Consultant Report STC CR-65

ADDENDUM TO THE ANNEXES TO THE SUSTAINABILITY OF THE SOVIET ARMY IN BATTLE

by

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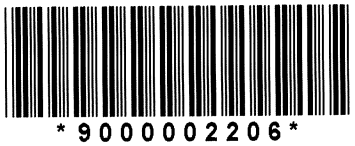

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PREFACE

The Annexes to the report on the Sustainability of the Soviet Army in Battle were provided in order to show examples of Soviet Operational Analysis and battlefield calculation techniques and theory. In particular, Annex E is an abbreviated translation of the Soviet publication 'Takticheskiye Raschety' (Tactical Calculations) by A. Ya. Vayner (1982), which contains many mathematical formulae reproduced in the Annex.

Due, however, to the inadequacies of the word processing system in attempting to reproduce these formulae exactly, it is recognised that, to the mathematically inclined, there are obvious deficiencies and typographic errors in many of the formulae.

For this reason M. E. Kelly has undertaken to produce this short addendum to the annexes, in order to correct certain errors and to reproduce some of the formulae in a more mathematically readable format. Where the formula is easily understandable, even if not aesthetically pleasing, it is not reproduced here. In addition certain changes were necessary in the 'legends' to some of the formulae and only these changes are given here, not a reproduction of the complete legend.

ANNEX E

EXAMPLES OF NORMS IN MATHEMATICAL MODELLING.

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EXTENSION OF NORMS IN TO MATHEMATICAL MODELLING, NOMOGRAMS AND CALCULATION FORMULAE.

Nomograms and calculation proformae are designed to assist in achieving a clear cut appreciation of a particular situation based on a common approach to a problem, and to produce a solution in the shortest possible time.

Group 1. In Group 1 there are two examples of particular interest:

(a) Nomogram No 2, Appendix 1. This could be used in the commitment to battle of a second echelon sub-unit, unit or formation. The timing for the committal of a second echelon to battle is critical if the advance is to be developed without a halt. The committal to battle of the second echelon must be before the advance shows signs of slowing up or the impetus will be lost. On the other hand, if the committal of the second echelon is premature, unnecessary casualties will ensue and the shock of the attack will be lessened. The accurate plotting and reconnaissance of the second echelon startline (SL) is vital.

(b) Nomogram No 8, Appendix 1. In the calculation, 'n' denotes the norm of fuel consumption for 100km in litres and 'k' denotes the additional factor for movement conditions. In the example, K = 1.2 (i.e. depicts a worse movement condition than a movement coefficient of K = 1.0, perhaps due to hilly ground or swamps, etc.), this represents the additional supplement of 20% to the fuel norm.

Group 2. In this category the "meeting engagement" is of particular interest. (Nomogram No 9 and Proformae Nos 3 and 4, and Nomogram No 13 - the required number of anti-tank weapons to destroy tanks). This calculation can be reversed to work out the number of tanks required to affect a breakthrough. See also Nomogram No 14 (the determination of the number of weapons to carry out a task and their effectiveness). In Proforma No 5 for the determination of the necessary manpower and weapons to restore sub-units and, units to battle worthiness, note that the restoration need not necessarily be up to the original establishment but merely sufficient to obtain the required degree of superiority.

Group 3. Includes crossing water obstacles, mining, engineer fortifications and improvements.

Group 4. This category covers artillery in "engagement of personnel and

weapons" - Nomogram No 18 enables a quick appreciation of the engagement to be made, Nomogram Nos 19 and 20 "duration of fire in a gun position" and "time spent in changing gun positions", tells us how long the battery or artillery battalion will be non-effective in terms of bringing fire to bear on targets. See also Proforma No 7 "calculation of fire capabilities".

Group 5. Covers logistics:- the transportation of loads by road, rail and by air.

Appendix 1 to Annex E

NOMOGRAM 1. Duration of a March.

The method of calculating the time necessary for the transfer of sub-units from one area to another is dependent on the following data: the length of march (from the startline (SL) to the nearest point of the new concentration area), the average speed of the column, the duration of halts in the course of movement and the time taken to pull off the ground into the new concentration area (which is only considered in the case when the depth of the concentration area is less than the length of the moving formation).

Formula of calculation:

$$t = \frac{D}{V} + t_n + t_{Bt}$$

where:

t = Duration of march - hrs.

D = Length of route - km.

V = Average speed of moving column - kph.

t_n = Overall time of halts in the course of the move - hrs.

t_{Bt} = Time taken to pull off road into new concentration area - hrs.

Example of calculation by nomogram.

"Calculate the duration of a move along a 80km route with an average speed of movement is 35kph, duration of halts 1hr 30mins; time taken to pull off road into new area - 30mins.

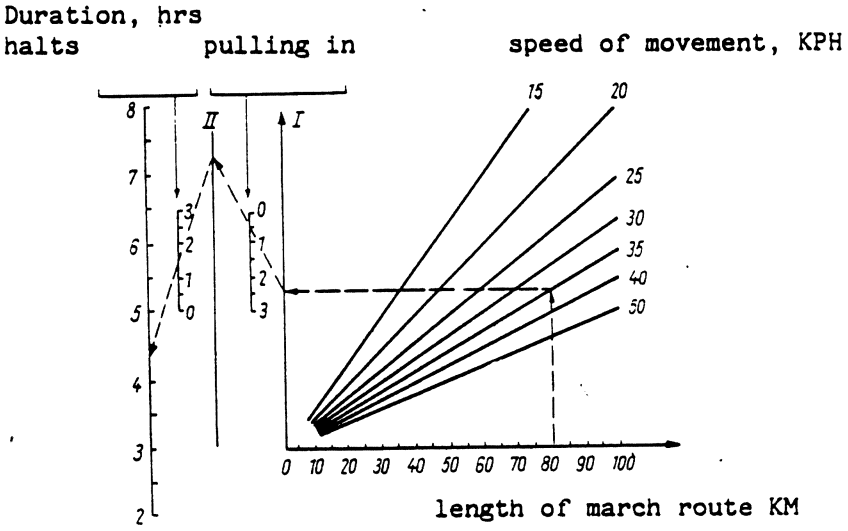

Figure 35. Nomogram for the Calculation of the Duration of a March.

Answer from the nomogram scale = 4.3hrs, i.e. 4hrs and 20mins.

NOMOGRAM 2. Duration of Column Moving Out to Startline.

The basic data for calculating when a mobile column should start moving in order to arrive at the startline in good time is the distance between the startline and the area where troops are concentrated taken together with speed of movement.

Formula of calculation:

$$t_H = T - \frac{D_u}{V_B} \times 60$$

where:

t_H = Time of column starts to move - hrs and mins.

T = Time head of column passes nominated line - hrs and mins.

D_u = Distance of startline (or point) from concentration area of troops - km.

60 = Coefficient of converting hrs to mins.

V_B = Speed of movement of mobile column in pulling out - kph.

Example of calculation.

Determine the start time of a mobile column, if the time of passing the startline by the head of the column is to be 2100hrs. The distance from the startline is 9km, speed of movement of the column on moving out is 15kph.

$$t_H = 2100 - \frac{9 \times 60}{15} = 2100 - 36\text{mins} = 20.24\text{hrs}$$

Answer: The column must commence moving out of its deployment area at 2024hrs 6 Aug to make the startline at 2100hrs.

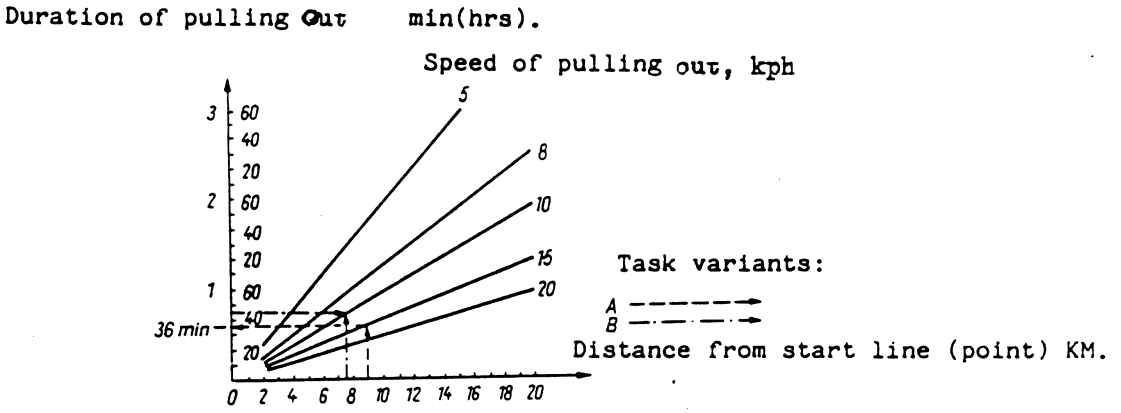

Figure 36. Nomogram for the Calculation of the Duration of Movement of Marching Columns to the Startline (Point).

Example of calculation using the Nomogram.

1. Using the same conditions as in the example above, the same answer is achieved, i.e. the time is 36mins for moving from the deployment area, to the startline - the column must start to move at 2024hrs.

2. With the assistance of the nomogram it is also possible to calculate the necessary speed of movement of the column to the startline (point).

Following example b, with a distance from the deployment area of 7.5km the mobile column needs to move at a speed of not less than 10kph if it is to reach the startline in 45 mins.

NOMOGRAM 3. Time Taken to Occupy New Concentration Area by a Mobile Column.

The time taken to occupy a new concentration area by a mobile column needs to be calculated only when the depth of the area is less than the length of the mobile column.

The depth of the concentration area, the length of the column, and the speed of movement in pulling in to the new area are the basic data for this calculation.

Formula of calculation:

$$t_{Bt} = \frac{G_K - G_R}{V} \times 60$$

where:

t_{Bt} = Time taken for mobile column to pull into new concentration area - mins.

G_K = Length of column - km.

G_R = Depth of concentration area - km.

V_{Bt} = Speed of movement of column in pulling into new area - kph.

60 = Coefficient of converting hrs to mins.

Example of calculation.

Determine the time taken by a column to occupy a new concentration area if the length of the column is 7km, depth of the concentration area is 3.5km, speed of movement of column in pulling into new area is 10kph.

Solution.

$$t_{Bt} = \frac{(7 - 3.5)}{10} \times 60 = 0.35 \times 60 = 21\text{mins.}$$

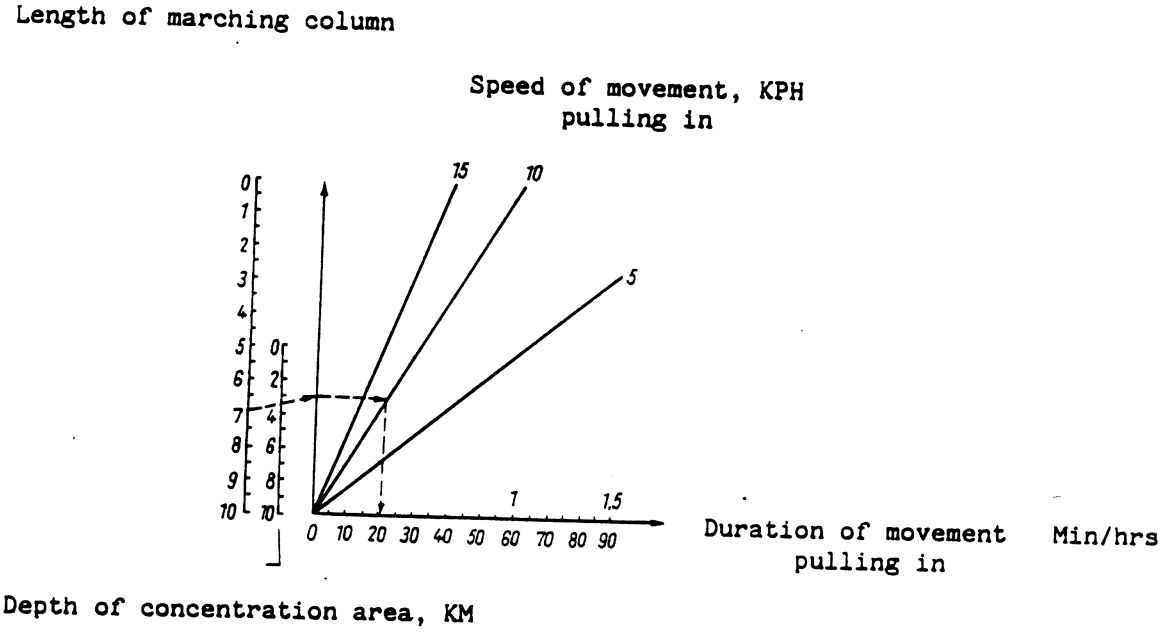

Figure 37. Nomogram for the Calculation of the Length of Time Taken for a Mobile Column to Pull into new Concentration Area.

The nomogram in the example above provides the same time - 21mins.

NOMOGRAM 4. Length of Mobile Formation Consisting of Several Mobile Columns.

This method is for determining the overall length of a moving formation on a route, provided the number of vehicles in the moving columns and distances between them is known. It is also used to determine the required distances between vehicles.

Formula of the calculation:

$$G_K = \frac{N_m \times d_m + (N_K - 1) \times d_K}{1000}$$

where:

G_K = Length of moving formation - km.

N_m = Overall number of vehicles in columns.

d_m = Distances between vehicles - m.

N_K = Number of moving columns.

d_K = Distances between columns - m.

1000 = Coefficient of converting m to km.

Example of calculation.

Determine the length of a moving formation consisting of four columns, if the overall number of vehicles is 169, distance between columns 600m, distance between vehicles 40m.

Solution.

$$G_K = \frac{169 \times 40 + (4 - 1) \times 600}{1000} = \frac{6760 + 1800}{1000} = 8.6\text{km}$$

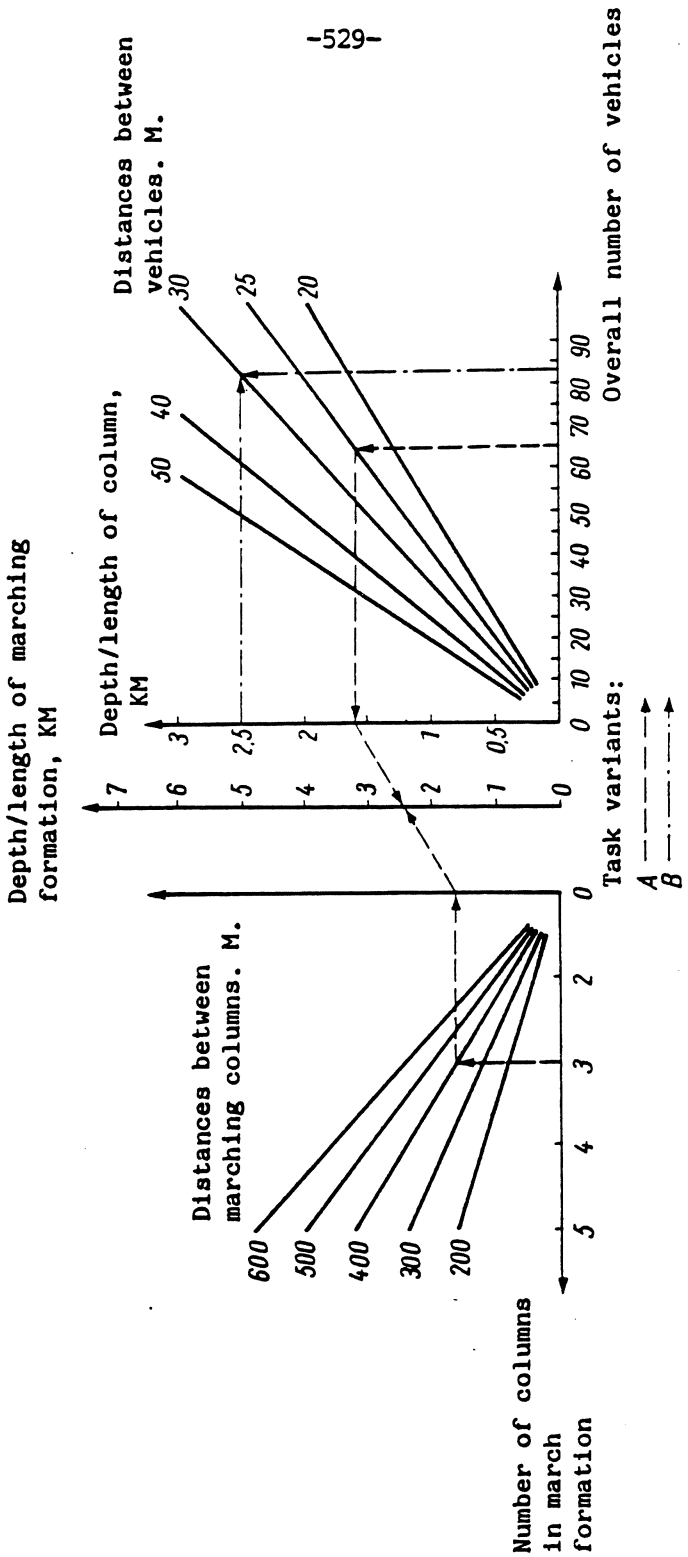

Figure 38. Nomogram for the Calculation of the Depth/Length of a Mobile Formation Consisting of Several Columns.

Example of calculation using to the nomogram.

1. Determine the length of a moving formation if there are 3 moving columns and distances between them 400m, overall number of vehicles 65, distance between vehicles 25m (variant a).

2. Determine the necessary distances in a column, consisting of 83 vehicles, given that the length of the column must not exceed 2.5km (variant b).

Solution - 30m.

NOMOGRAMS 5 and 6. Time Taken to Pass Narrow Places/Difficult Sectors of Routes.

There are two types of difficult sectors to be overcome: minor ones, of a length considerably less than the mobile columns, and larger ones, where the length is greater than the length of the mobile column. The basic data for minor sectors is the number of vehicles in the column, distances between them and speed of movement of vehicles when passing the sector. For the larger sector they are: the length of the moving column; the length of the sector to be covered, and; the speed of movement.

Formula of calculation for small obstacles:

$$t = \frac{N_m \times d_m \times 0.06}{V}$$

where:

t = Time taken to overcome obstacle - mins.

N_m = Number of vehicles in a column.

d_m = Distance between vehicles - m.

0.06 = Coefficient of converting kph into mpm.

V = Speed of movement of vehicles in the sector to be overcome.

Example of calculation.

— Determine the time taken to overcome a steep slope by a column of 54 vehicles, if the distance between vehicles is 75m, permitted speed of movement on the sector is 10kph.

Solution:

$$t = \frac{54 \times 75 \times 0.06}{10} = 24\text{mins}$$

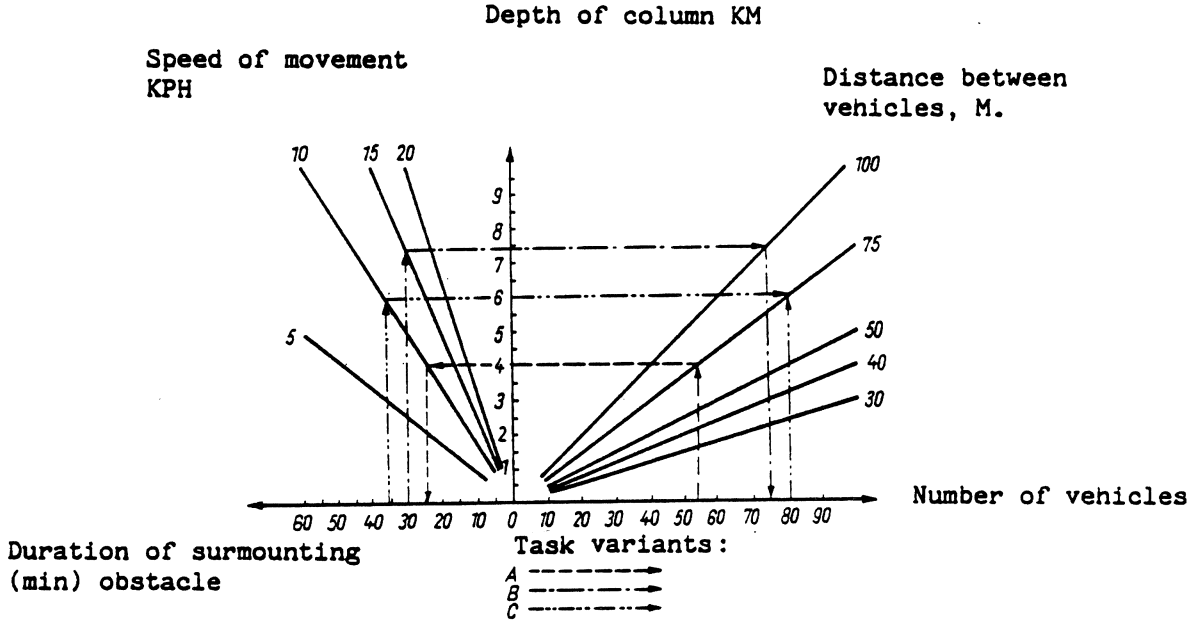

Figure 39. Nomogram for the Calculation of the Time Taken to Pass Narrow Places on Movement Routes.

Calculation using the nomogram gives - 24mins (variant a). With the assistance of the nomogram it is also possible to solve other problems. For example, (1) determine the number of vehicles able to traverse an obstacle on a route in the course of 30mins, if the required speed of movement is not more than 15kph, and the distance between vehicles 100m.

Solution: variant b on the nomograph - 75 vehicles in 30 mins.

(2) Calculate the distance between vehicles in a column of 80 vehicles in order that the column crosses a bridge within 30mins at a permitted speed of not more than 10kph.

Solution: variant c.

Formula of calculation for large obstacles:

$$t = \frac{G_K + D}{V}$$

where:

t = Duration of overcoming obstacle - hrs.

G_K = Length of column - km.

D = Length of sector to be overcome - km.

V = Speed of movement across the obstacle - kph.

For example of calculation using by nomograph, see Figure 40.

1. Determine the time required for overcoming a boggy strip of road, if the length of the sector is 5.5km, depth of the column 2.5km, average speed on the sector 15kph. Solution (variant a) - 32mins.

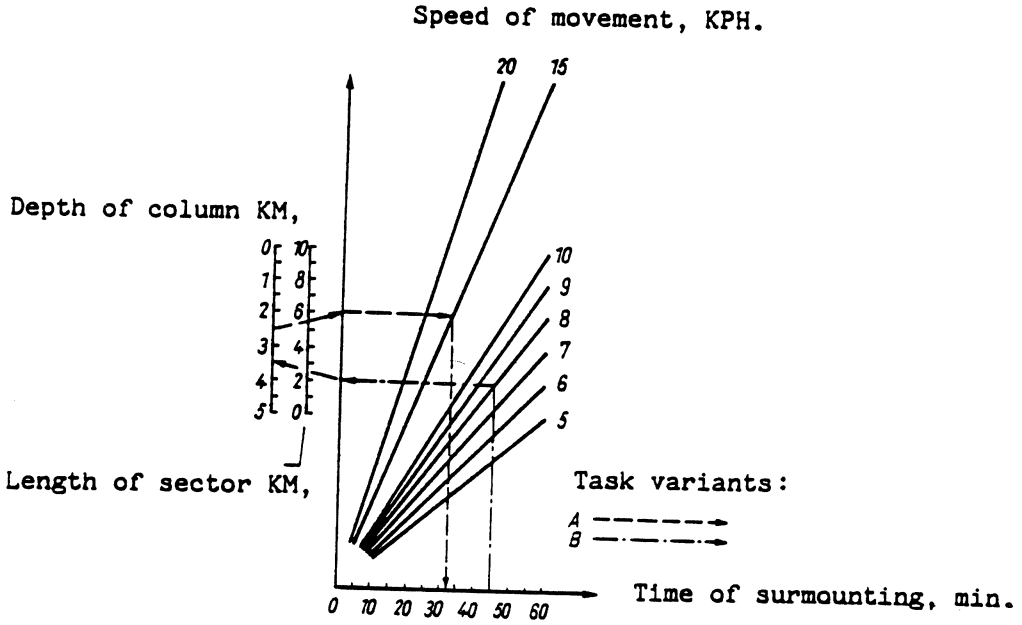

Figure 40. Nomogram for the Calculation of the Time Taken to Pass Difficult Sections on Movement Routes.

2. With the assistance of this nomogram it is possible to determine (variant b) what length of column can negotiate a pass 2.5km long at a speed of 8kph in a given time.

Solution: (variant b) - 3.5km.

NOMOGRAM 7. The Time of Passing the Startline (Point)/Report Line (Point) by the Head and Rear of a Column.

The basic data required for the calculation is: details on the makeup/construction of the moving formation, depth of moving columns and the established distances between them, speed of movement and the time of passing the other line (point) by the head of the moving formation.

Formula of the calculation:

$$t_1 = T_{i-1} + \frac{60d_i}{V}; \qquad t'_i = t_i + \frac{60D_i}{V}$$

where:

t_i = Time of passing line (point) by head of the i th moving column - hrs and mins.

T_{i-1} = Time of passing line (point) by the tail in front of the column in front of the i th moving column - hrs and mins.

d_i = The established distance between columns - km.

60 = Coefficient of converting hrs to mins.

V = Average speed of movement - kph.

t'_i = Time of passing the line by the rear of the i th column - hrs and mins.

D_i = Length in the i th column - km.

Example of calculation.

Determine the time of passing control point no 1 by the head of the formation and the rear of No 3 column, if time of passing the startpoint by the rear of the column is to be 2115hrs, the distances between columns is 1.5km, the length of a column is 1.8km, speed of movement 25kph.

Solution:

$$t_3 = 2115 + \frac{1.5 \times 60}{25} = 2115 + 0.04 = 2119$$

$$t_3 = 2119 + \frac{1.8 \times 60}{25} = 2119 + 0.04 = 2123$$

i.e. the head of the third column in the movement formation passes report line No 1 at 2119hrs and the rear at 2123hrs.

Example of calculation using nomogram (Figure 41).

Determine the time to pass a startline by the head and rear of a moving column of 7km, when the distance between columns is 5.5km and the speed of movement is 25kph.

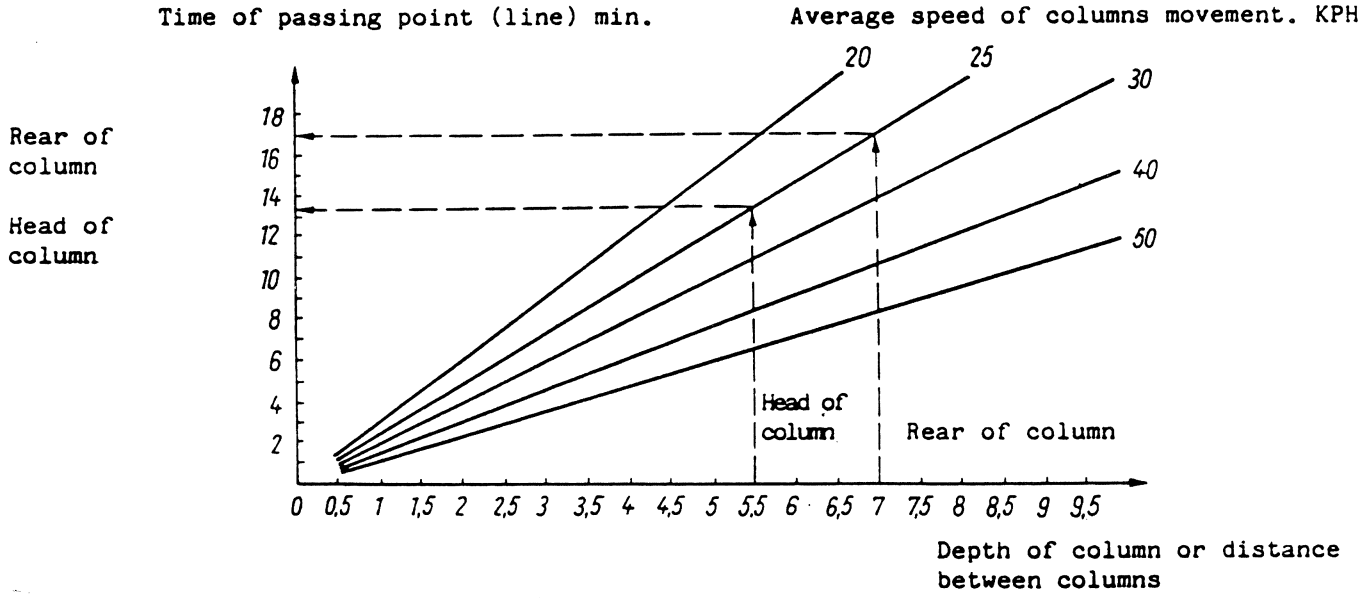

Figure 41. Nomogram for the Calculation of the Time of Passing a Line (Point) by the Head and Rear of a Column.

The nomogram gives 13.3mins for the front of the column. Rear of the column 17mins. So that the front column will be clear of the startline by 2030 (i.e. 2013 (head passing) and 0.17 (rear passing)).

Proforma No 1. For the Calculation of Transit Time to a New Area.

Formula of calculation.

$$t = T + \frac{D}{V} + \frac{G_K - G_P}{0.6V} + t_n \quad \text{for } G_K > G_P$$

where:

t = Duration of regrouping to new area - hrs.

T = Time (astronomical) of passing start point (line) by front of column - hrs and mins.

D = Length of route and distance away of new concentration area - km.

V = Average speed of movement.

G_K = Length of column.

G_P = Depth of new concentration area - km. (Formula is valid only for the case where this depth is less than the length of the column).

0.6 = Coefficient, which takes into account the lowering of the average march speed in drawing into the new concentration area.

t_n = Duration of halts en route - hrs.

Table 102. Proforma to Calculate Transit Time to the New Area.

Ser No.	Starting Data Determined Scales and Oprations and Operations	Degree of Accuracy Accuracy	Variant of move forward Example	1	2	3	Remarks
1	2	3	4	5	6	7	8
1	Length of march route	km (1.0)	167				
2	Average speed of movement	kph (1.0)	18				
3	Length of mobile column	km (0.1)	7.5				
4	Depth of concentration area	km (0.1)	4				
5	Duration of halts	hrs (0.1)	1.5				
6	Time of passing start point (line) (SL) (SP)	hrs mins	10.00				
7	(2):(2)	(0.1)	9.3				
8	(3)-(4)	(0.1)	3.5				
9	(2)x(0.6)	(0.1)	10.8				
10	(8):(9)	(0.1)	0.3				
11	Overall duration of march (5)+(7)+(10)	hrs (0.1)	11.1				
12	Time of concentration in new area (6)+(11)	hrs mins	21.06				

Proforma No 2. Length of Route, Average Speed and Duration of Movement of Moving Column.

Formula of calculation:

$$D = \sum_{i=1}^{n} L_i ; \qquad t_d = \sum_{i=1}^{n} \frac{L_i}{V_i}; \qquad V = \frac{D}{t_d};$$

$$t = t_d + \frac{G_k - G_p}{0.6V} + t_n$$

where:

D = Length of route - km.

L_i = Length of the i the sector - km (of the different types of road) which allows a speed of movement of kph of the columns.

t_d = Overall time on the route - hrs.

V_i = Speed of movement on the i th type of sector of the route - kph.

V = Average speed of movement - kph.

G_K = Length of column - km.

G_P = Depth of concentration area - km.

0.6 = Coefficient of reduction in speed in the drawing in of the column, depending on local conditions.

t_n = Overall time of halt.

t = Overall time (note that this term is not defined in the Russian version of the book, only in the German version).

Table 103. Proforma for the Calculation of the Length of March Routes, of Average Speed, of the Duration of Movement of Marching Columns.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	No. of Routes			Remarks
			Example	1	2	
1	2	3	4	5	6	7
1	Length of metalled roads	km (1.0)				
2	Speed of movement (metalled)	35				
3	Length of improved dirt roads	18				
4	Speed of movement (improved dirt roads)	25				
5	Length of dirt roads	21				
6	Speed of movement on dirt roads	15				
7	Length of field tracks	8				
8	Speed of movement (field tracks)	10				
9	Length of moving column	6.8				
10	Depth of concentration area	3				
11	Overall time for halts	1.5				
12	Length of march route (1)+(3)+(5)+(7)	89				
13	(1):(2)	1.2				
14	(3):(4)	0.7				
15	(5):(6)	1.4				
16	(7):(8)	0.8				
17	Time of movt. (13)+(14)+15)+(16)	4.1				
18	Average speed. (12)+(17)	22				
19	(9)-(10):0.6:(18)	3.8				
20	Time of movement to new area: (19):0.6):(18)	0.3				
21	Duration of transit: (11)+(17)+(20)	5.9				

NOMOGRAM 8. Amount of Fuel for Vehicles on the March.

The basic data for the calculation is: (1) the length of the march route; (2) fuel consumption for the type and mark of vehicle. The fuel consumption is calculated with a coefficient which takes into account conditions affecting movement (state of the road, weather, time of year, time of day, etc.).

Formula of calculation:

$$Q = \frac{D \times n \times K}{100} \times N$$

where:

Q = Required amount of fuel - litres.

D = Length of march route - km.

n = Norm of fuel consumption - litres/100km.

K = Coefficient introduced for the march conditions.

N = Number of vehicles of a given type.

Example of calculation.

Determine the required quantity of fuel for 75 vehicles to complete a march of 150km, if the norm of fuel consumption is 35 litres (per 100km) and the coefficient of the conditions of movement is 1.2.

Solution:

$$Q = \frac{150 \times 35 \times 1.2 \times 75}{100} = 4725 \text{ litres}$$

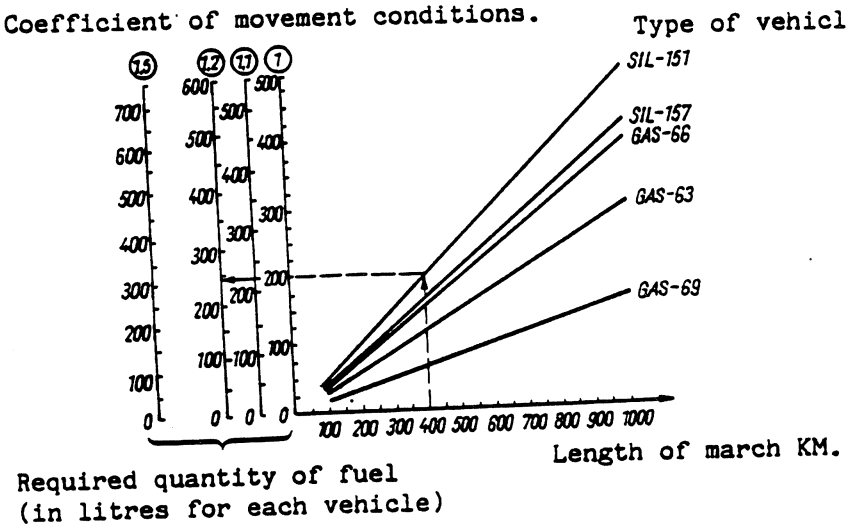

Figure 42. Nomogram for the Calculation of the Required Quantity of Fuel on the March.

Example of calculation using the nomogram.

To determine the fuel consumption for 35 ZIL 157 on a route of 400km, if the coefficient of movement conditions is 1.2.

The nomogram gives 240 litres - for each vehicle for 400km. Therefore for 35 vehicles 240 x 35 - 8400 litres.

Appendix 2 to Annex E

NOMOGRAM 9. Expected Time of Meeting and the Distance of the Probable Line of Meeting with the Enemy (encounter battle).

The expected time of meeting and the probable line of meeting with the enemy is determined taking by into account the reciprocal distances of the troops of both sides and the average speed of their movement.

Formula of the calculation:

$$t_B = \frac{D}{V_H + V_n}; \qquad L_P = t_B \times V_H$$

where:

t_B = Expected time of meeting with the enemy - km.

D = Distance between the troop groupings of both sides - km.

V_H = Speed of movement - own troops - kph.

V_n = Speed of movement - enemy troops - kph.

L_P = Distance of probable line of meeting with the enemy from the starting point (FUP) of own troops.

Example of calculation.

Determine the expected time of meeting and distance of the possible line of meeting with the enemy, if the enemy is situated at a distance of 63km, his average speed of movement 25kph, average speed own troops 20kph.

Solution.

$$t_B = \frac{63}{20 + 25} = \frac{63}{45} = 1.4\text{hrs} = 1\text{hr } 24\text{mins}$$

$$L_P = 1.4 \times 20 = 28\text{km}.$$

Solution: the meeting with the enemy is likely in 28km and 1hr 24mins.

Example of calculation using nomogram.

Determine the expected time of meeting and the distance of the probable line of meeting with the enemy if at 1800hrs 5 June the advancing enemy is 64km away, average speed of his movement is 15kph, speed of movement of own troops is 20kph.

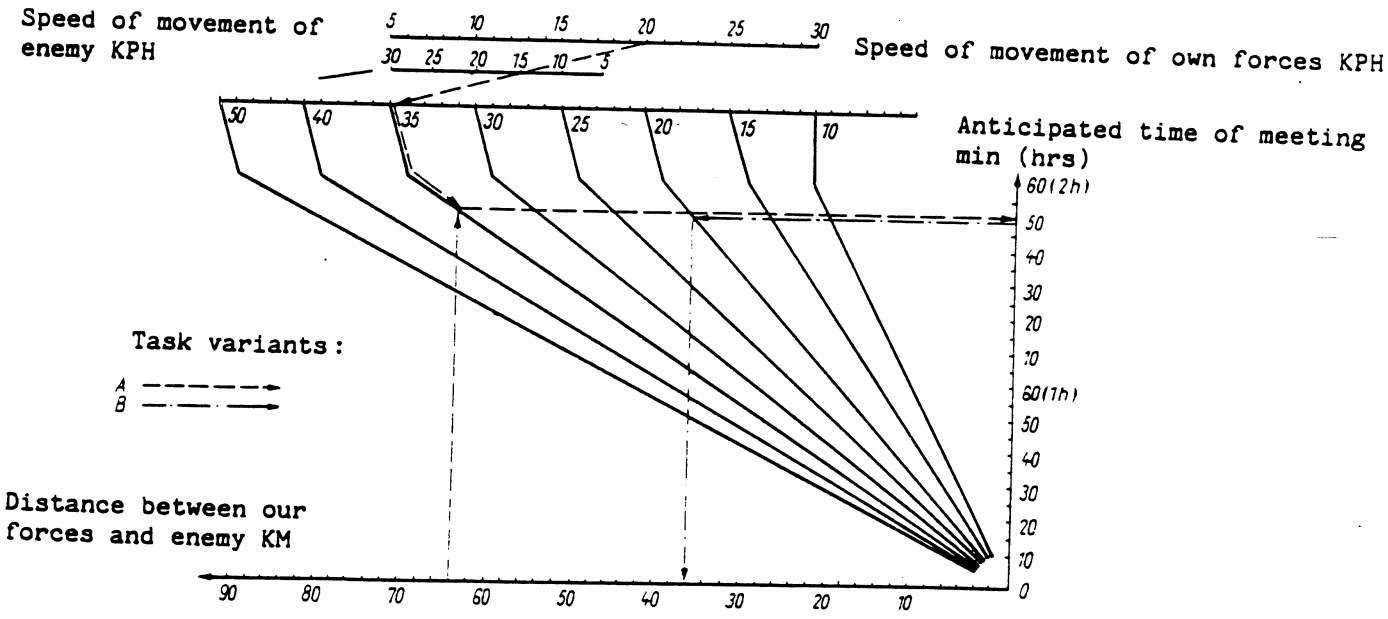

Figure 43. Nomogram for the Calculation of the Likely Time and the Distance of the Probable Line of Meeting with the Enemy.

The nomogram gives (variant a) - 1hr and 50mins - i.e. 1950hrs.

Calculating the distance of the probable line of meeting with the enemy (variant b), from the point of time 1hr 50mins horizontally to line-speed 20kph, (variant b) gives 36km.

Table 104. Proforma for Calculation of time of Advance and Deployment of Sub-Units in Switching to the Attack from the March.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			1	2	3
1	Distance of bound (switching to the attack) from enemy front line	km (0.1)			
2	Distance of bound (deployment into company columns) from bound (switching to the attack)	km (0.1)			
3	Distance of bound (deployment into battalion columns) from the bound (into company columns)	km (0.1)			
4	Distance of bound (regulatory) from bound (deployment into battalion columns)	km (0.1)			
5	Distance of bound (point) regulatory from the startline (point) (SL) (SP)	km (1.0)			
6	Distance of SL(SP) from sub-units location	km (0.1)			
7	Speed of movement into the attack	km (1.0)			
8	Average speed of sub-units	km (1.0)			
9	Length/depth of moving column - 1st echelon	km (0.1)			
10	Distance between columns of 1st and 2nd echelon	km (0.1)			
11	(1) x (60)	(1.0)			
12	Time of move forward to bound of switching to the attack (H-)	min (1.0)			
13	(2) x (90)	(1.0)			

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			1	2	3
14	(13):(8)	(1.0)			
15	Time of move forward to bound (deployment into company columns)	min (1.0)			
16	(3) x (60)	(1.0)			
17	(16):(18)	(1.0)			
18	Time of move forward to broad (deployment into battalion columns) (H-):(15) + (17)	min (1.0)			
19	(4) x (60)				
20	(19):(18)	(1.0)			
21	Time of passing bound (regulatory) (H-):(18) + (20)				
22	(5) x (60)	(1.0)			
23	(22):(8)	(1.0)			
24	Time of passing SL(SP) (H-)	min (1.0)			
25	(6) x (90)	(1.0)			
26	(25):(8)	(1.0)			
27	Time of beginning of pulling out of 1st echelon (H-)	min (1.0)			
28	(9) + (10)	(0.1)			
29	(28) x (90)	(1.0)			
30	(29):(8)	(1.0)			
31	Time of passing SL(SP) of 2nd echelon (H-):(24) - (30)	min (1.0)			

Table 105. Proforma for the Calculation of the Time and Distance of the Probable Line of Contact/Meeting with the Enemy.

Ser No.	Starting Initial Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			Example	1	2
1	Start of move forward of own troops	hrs mins	20.00 4/6		
2	Start of move forward of enemy tps	hrs mins	21.00 4/6		
3	Distance between groups	km (1.0)	105		
4	Delay of move forward of own troops (relative to enemy troops): (1) - (2)	hrs (0.1) in (1)>(2)	-		
5	Overall duration of halts of own forces 'en route'	hrs (0.1)	0.3		
6	Overall duration of delay of own troops by the enemy	hrs (0.1)	-		
7	Speed of movement of own troops	kph (1.0)	28		
8	Delay in move forward of enemy tps (relative to own troops): (2) - (1)	hrs (0.1) in (2)>(1)	1		
9	Overall duration of halts of enemy troops 'en route'	hrs (0.1)	0.5		
10	Overall delay of enemy troops by own troops	hrs (0.1)	0.6		
11	Speed of move forward of enemy tps	kph (1.0)	19		
12	(4) + (5) + (6)	(0.1)	0.3		
13	(12) x (7)	(0.1)	8.4		
14	(8) + (9) + (10)	(0.1)	2.1		
15	(14) x (11)	(1.0)	40		
16	(3) + (13) + (15)	(1.0)	153		

Ser No.	Starting Initial Determined Scales and Operations	Degree of Accuracy	Variant of Move Forward		
			Example	1	2
17	(7) + (11)	(1.0)	47		
18	Anticipated of contact/meeting (relative): (16): (17)	hrs (0.1)	3.3		
19	Duration of movement up to bound/ line of contact/meeting (18) - (12)	hrs (0.1)	3		
20	Distance of probable bound/line of contact/meeting: (19) x (7)	km (1.0)	84		

NOMOGRAM 10. Calculating the Commander and Staff's Working Time to Organise the Engagement of an Advancing Enemy.

To determine the time the commander and staff have available to organise the engagement of the advancing enemy requires the following data: the distance away of the enemy, the speed of his advance, the range of effective fire of own weapons and time necessary for the preparation of sub-units for firing. This is based on engaging the enemy at maximum range.

Formula of calculation:

$$t = \frac{(D - d) \times 60}{V_n} - t_g$$

where:

t = Time available to commanders and staff to organise the engagement of the advancing enemy - mins.

D = Distance away of advancing enemy - km.

d = Maximum range of effective fire of own weapons - km.

60 = Coefficient of conversion of hrs to mins.

V_n = Speed of advancing enemy - kph.

t_g = Minimum warning time sub-units will need to prepare for engaging advancing enemy.

Example of calculation.

Determine how much time the commander and staff have at their disposal for organising the engagement of the advancing enemy, if he is 25km away and advancing at 15kph. Effective range of own weapons 12km, time subordinate sub-units need in order to get ready - 30m.

$$t = \frac{(25 - 12)}{15} \times 60 - 30 = 22\text{mins}$$

Example of calculation using nomogram.

To determine the time available to the commander and staff to organise the engagement of the advancing enemy at a distance of 15km away, his speed of movement 12kph, effective range of own weapons 6km, warning time sub-units need to get ready - 20mins.

Time available for work of commander and staff equals - 25mins.

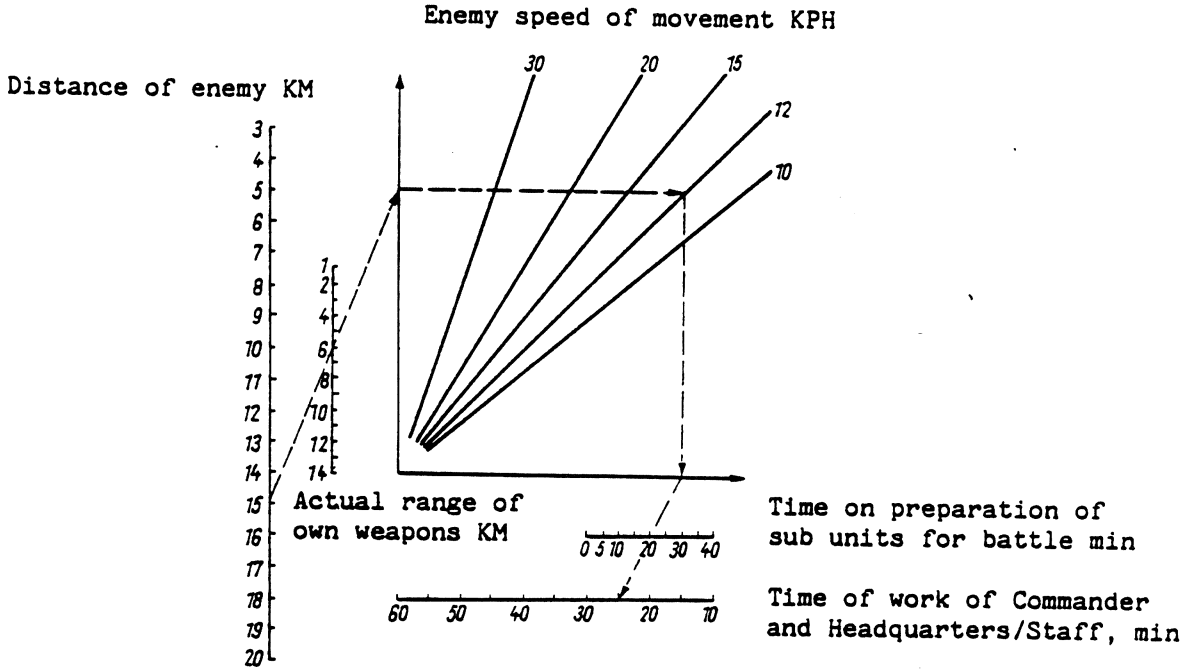

Figure 44. Nomogram for the Calculation Time Available to the Commander and Staff's for Organizing for Battle with Advancing Enemy.

EDITOR'S PREFACE

The textbook TAKTIKA (Tactics) was published by the Soviet Military Publishing House (Voyenizdat) in Moscow in 1984. It replaces an earlier version published in 1966. A translation was sponsored by the Canadian Chief of Intelligence and Security which is the basis of the present work. This edition was prepared in response to a request of the Director of Infantry for material to support his new Armoured Infantry Training Package. The aim of this abridgement is to provide the British reader with an insight into current Soviet tactical thinking in a manageable form. It is hoped that the flavour and the basic meat of the original has survived, without the deterrent of a mass of polyunsaturated verbage. Reading this book is not a substitute for reading the Vol II, Part 3 of the Army Field Manual (Soviet Tactics). The two books should complement each other. If the AFM awakens the reader to the difference between Soviet and British tactics, then reading TAKTIKA can help him to understand why the Soviets approach the subject as they do. Conversely the AFM contains many details of timings, distances and organization which the Soviets would not choose to publish in a work intended for open circulation.

To understand TAKTIKA more fully the reader will want to know who wrote it, for what group of readers and how it fits in to the range of Soviet tactical writings.

The book was produced by a collective of authors headed by Lieutenant General V G Reznichenko, a professor and head of the Tactics Department at the Frunze Military Academy and the other authors are in all probability members of the same department. All Soviet military academies, besides their teaching role, are charged with conducting research into military science. The Frunze is the oldest and most prestigious of these academies. The authors have produced a range of other works on tactics; for example, Major General Sidorenko, who wrote Chapter 3, wrote a most interesting book on 'The Offensive' during 1970. All five authors were involved in the previous edition of 1966. It is interesting to note that the team has therefore been working together for about 20 years. It is an extra mark of the authority of the 1984 edition that it was reviewed for publication by Colonel General Gareev, a Deputy Chief of the General Staff, one of the Soviet Army's leading writers on doctrine.

TAKTIKA, we are told, is written for officer cadets and army officers (up to battalion level). The Soviet Army's basic guiding documents in tactics are the combat regulations. These were re-issued in about 1982. They carry to full force of law and abound in phrases such as "must", "is obliged to". But these forbidding documents are somewhat brief and cannot cover every eventuality. To educate the Soviet commander to put these regulations into practice the Soviet Army therefore issues manuals such as TAKTIKA. TAKTIKA in fact is the 'key-stone' manual and is being followed by volumes dealing with more detailed subjects such as 'The Motor Rifle Battalion in Battle' or 'The Forward Detachment'. The completed range will be most impressive and can be updated by articles in the military press and lectures.

The appearance of TAKTIKA marked official acceptance of the need to plan for non-nuclear operations. For some years to come it will provide a crucial insight into Soviet concepts of a future European battlefield.

NOMOGRAM 11. The Anticipated Time and Speed of Catching Up in Pursuit of the Enemy.

The basic data needed for this calculation is, distance of the enemy from own troops, average speed of movement of own troops and the enemy and the period of time available in which to catch him up.

Formula of calculation:

$$t_d = \frac{D}{V_H - V_n}$$ (For determining the time of catching up)

$$V_H = \frac{D + t_d \times V_n}{t_d}$$ (For determining the speed of catching up)

where:

t_d = Time of catching enemy - hrs.

D = Distance away of enemy - km.

V_H = Speed of pursuit of enemy - kph.

V_n = Speed of movement of enemy - kph.

Example of calculation.

1. To determine, within how much time own troops will catch up with the retreating enemy, if his is 20km away, his speed of movement is 10kph, and speed of pursuit by own troops is 25kph.

Solution:

$$t_d = \frac{20}{25 - 10} = \frac{10}{15} = 1.3\text{hrs} = 1\text{hr } 20\text{mins}$$

2. To determine the speed of pursuit needed in order to catch the enemy after 45mins at a distance of 15km when his speed of movement 12kph.

$$V_H = \frac{15 + 0.75 \times 12}{0.75} = 32\text{kph}$$

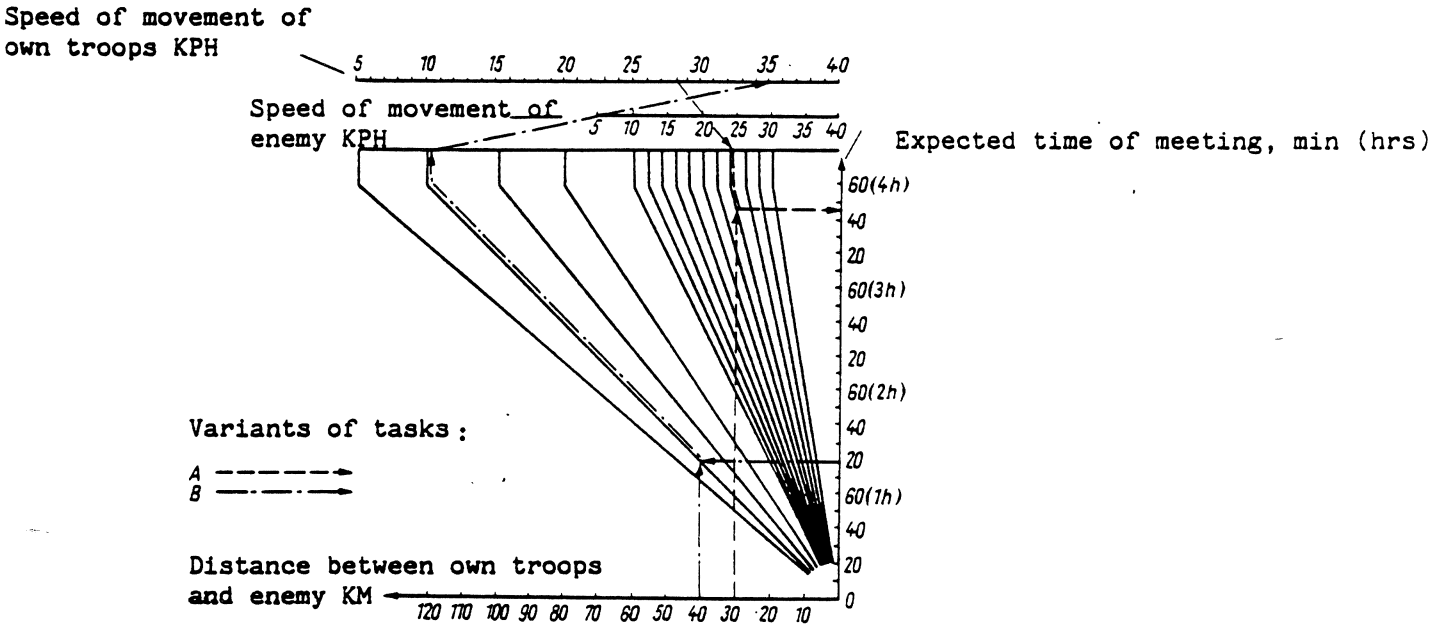

Figure 45. Nomogram for the Calculation of the Expected Time and Speed Needed to Overtake in Pursuit of the Enemy.

To determine the expected time of catching up with the enemy if he is 30km away, his speed is 21kph and speed of own troops in pursuit is 28kph.

Variant a gives 3hrs 45mins.

3. To determine the required speed for overtaking and intercepting the enemy within 1hr 20mins. Distance away of enemy is 40km and his speed is 5kph.

Variant b gives 36kph.

NOMOGRAM 12. Expected Doses of Radiation of Personnel.

The basic data needed for this calculation is, the length/extent of the contaminated sector of the route, the average level of radiation on the route, the speed of movement of sub-units crossing the zone, the level of protection of personnel afforded by transport. With this method it is also possible to calculate the required speed for crossing a given zone so that personnel do not receive radiation doses higher than those authorised.

Formula of calculation:

1. Expected dose of radiation.

$$D = \frac{P \times L}{K \times V}$$

2. Required speed of movement.

$$V = \frac{P \times L}{K \times D}$$

where:

D = Expected dosage of radiation of personnel - R.

P = Average level of radiation on route - R/hrs.

L = Extent/length of contaminated sector of the route - km.

K = Coefficient of degradation of radiation depending on personnel protection factor.

V = Speed of movement in overcoming zone of radio-active contamination.

3. Average level of radiation on the route is determined on the basis of the data obtained by NBC reconnaissance.

Example of calculation by nomogram.

1. Determine the anticipated dose of radiation of personnel crossing a sector of radio-active contamination with the level of radiation at 60 R/hr, if the length of the contaminated sector of route is 12km, sub-unit speed 15kph, coefficient of degradation 2.

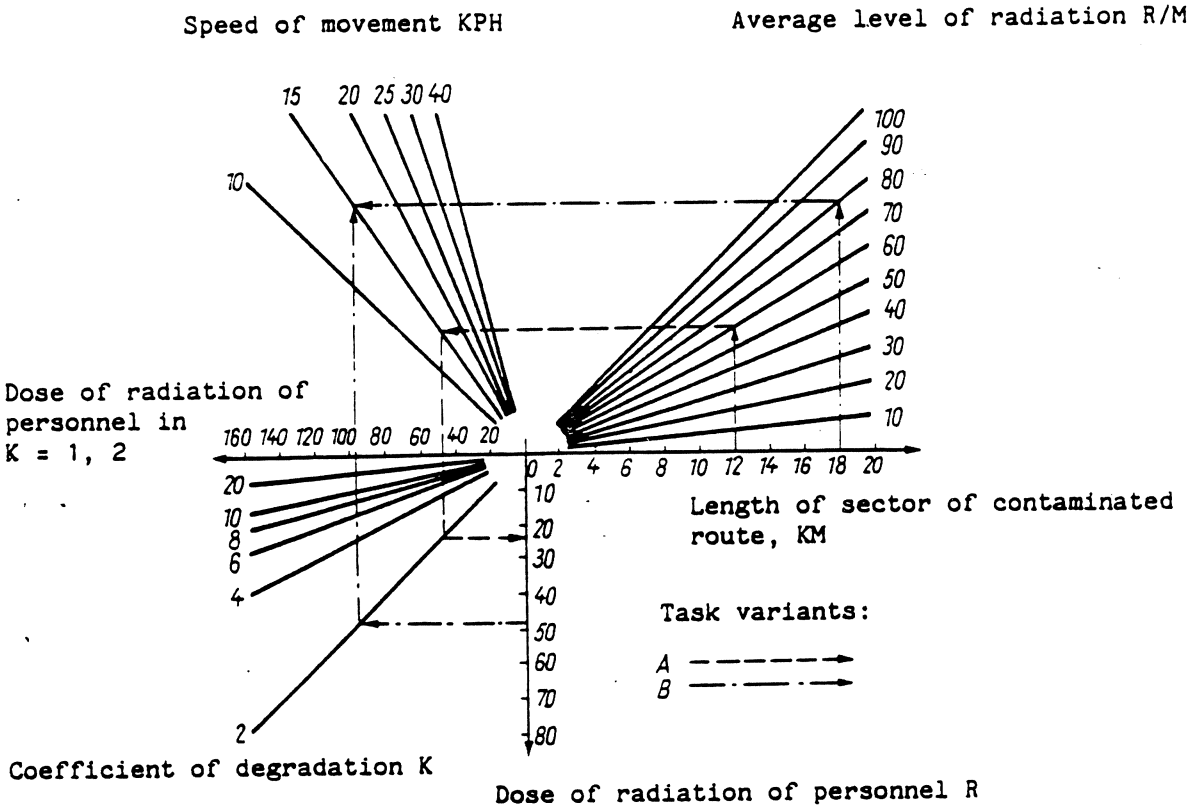
Speed of movement KPH
Average level of radiation R/M
15 20 25 30 40
10
100 90 80 70 60 50 40 30 20 10
Dose of radiation of personnel in K = 1, 2
160 140 120 100 80 60 40 20
0 2 4 6 8 10 12 14 16 18 20
20 10 8 6 4 2
10 20 30 40 50 60 70 80
Length of sector of contaminated route, KM
Task variants:
A
B
Coefficient of degradation K
Dose of radiation of personnel R

Figure 46. Nomogram for the Calculation of Radio-Active Contamination of Personnel Crossing a Zone of Radio-active Contamination.

Variant a gives 24 rontgens (R).

2. To determine the speed necessary to cross a contaminated zone so that personnel do not receive more than 48R. Conditions: extent of contaminated sector of route 18km, average level of radiation on route 80 R/hr, coefficient of radiation reduction/degradation (e.g. due to protection of vehicle).

NOMOGRAM 13. Graph for Calculating Required Number of Anti-Tank Weapons.

This graph has been combined with the following example to avoid duplication. Ed.

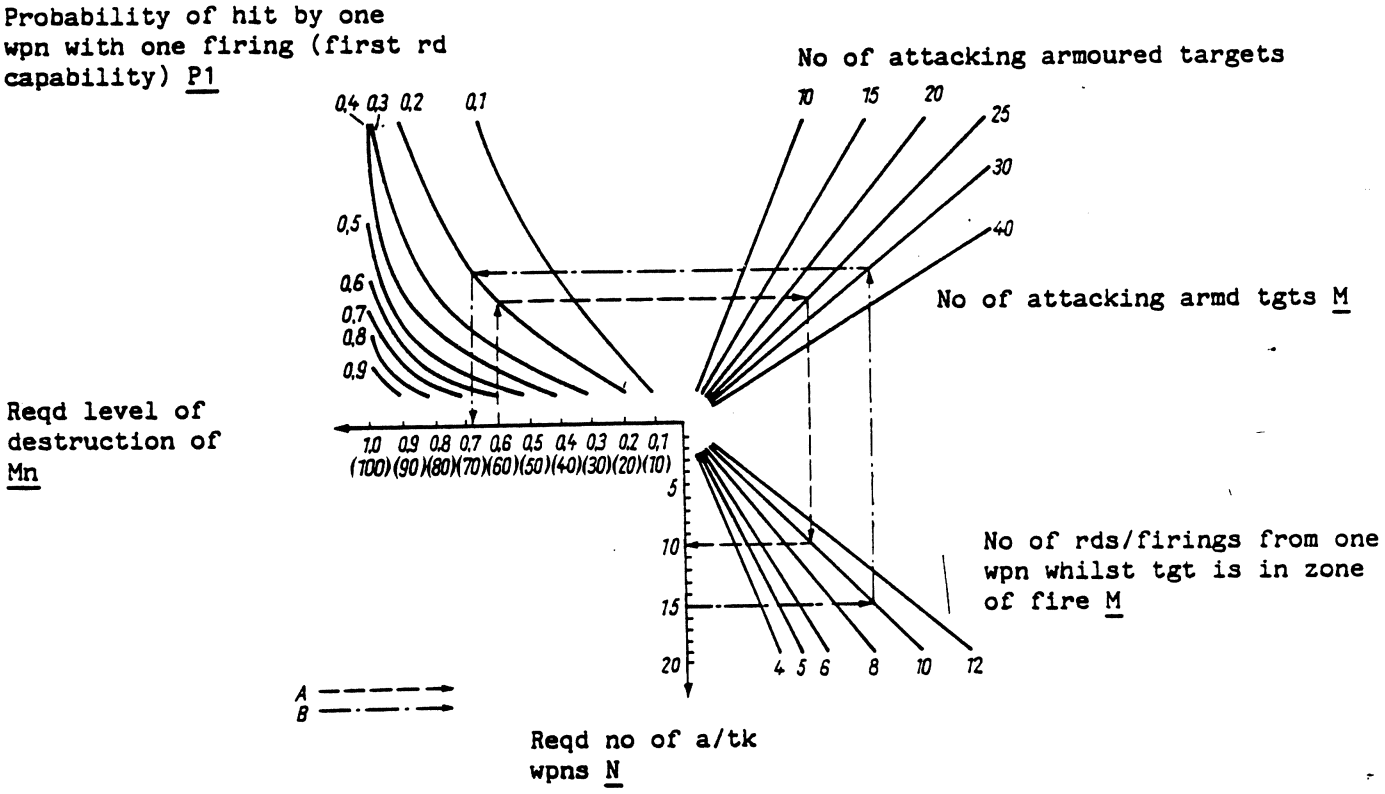
Probability of hit by one wpn with one firing (first rd capability) P1
No of attacking armoured targets
No of attacking armd tgts M
Reqd level of destruction of Mn
No of rds/firings from one wpn whilst tgt is in zone of fire M
Reqd no of a/tk wpns N
A
B

Figure 47. Nomogram for Calculating Required Number of Anti-Tank Weapons.

NOMOGRAM 14. Determining of the Number of Different Weapons Needed for a Given Task and Their Effectiveness.

This method is intended for calculations for using weapons in attack or defence, and for using reconnaissance or communications means under different conditions. Initially the calculation is made for one type of weapon, determining its overall effectiveness or the overall general requirement in weapons or equipment. The data needed for this calculation is: the number of weapons available; the degree of fulfilment of the mission (e.g. the % of enemy vehicles to be destroyed, etc.); the effectiveness of the weapons to be used. The last is expressed by the probability of the degree of fulfilment of the task (P of K) or by the average factor of damage to the target in question (a 'single weapon' is also taken to mean a group, of weapons amalgamated as a single target). Such data includes the probability of the destruction of the target, the extent of damage, inflicted on the target, the reliability of communications channels, the ability to detect an enemy target, the ability of ferries to keep crossing water obstacles in a set period of time, the probability of overcoming enemy air defences, etc. This data is obtained from exercise results and from statistical data of tactical and technical characteristics.

The formulae for calculating the degree of accomplishment of task by a given number of weapons is expressed as follows:

the probability of carrying out the task

$$P_n = 1 - (1 - P_1)^n$$

the mathematical expectancy (mean probability) of damage:

$$M_n = 1 - (1 - M_1)^n$$

where:

P_n = Probability of completion of task by a group of similar weapons.

P_1 = Probability of completion of task by one weapon.

M_n = Mean level of damage inflicted on the enemy by a group of weapons.

M_1 = Mean level of damage inflicted on the enemy by one weapon.

n = Number of available weapons.

The necessary number of weapons can be calculated through the following equations:

(i) by the probability of weapon success:

$$n = \frac{\log (1 - P_n)}{\log (1 - P_1)} \qquad \text{where } P_n > P_1$$

or

(ii) by the expected level of inflicted damage:

$$n = \frac{\log (1 - M_n)}{\log (1 - M_1)} \qquad \text{where } M_n > M_1$$

The formula for the calculating of the effectiveness of heterogeneous (different types) of weapons which are to carry out the general task, is:

$$P_n = 1 - (1 - P_1)(1 - P_2)....(1 - P_i)$$

where:

P_n = Degree of fulfilment of task.

P_1, P_2,..., P_i = Effectiveness of weapons, which are to be allotted for the accomplishment of the task.

Example of calculation.

Determine the probability of detecting an enemy object by combined use of three means of reconnaissance, if their effectiveness, expressed in the probability of detecting the enemy object is:

$$P_1 = 0.4; \quad P_2 = 0.6; \quad P_3 = (0.8)$$

Solution:

$$P_n = 1 - (1 - 0.4)(1 - 0.6)(1 - 0.8)$$

$$= 1 - (0.6 \times 0.4 \times 0.2)$$

$$= 1 - 0.0048$$

$$= 0.95$$

That is probability of detecting an enemy object by these given means of reconnaissance/detection is virtually absolute.

From the example it can be seen that the probability of carrying out the task, grows with the increase in the number of means used, but not in direct proportion.

Examples of the calculations using nomograms (see Figure 48.).

1. Determine the probability of destruction of an enemy object by a strike by three weapons, if the probability of destruction of the object by one weapon of a given type equals 0.4.

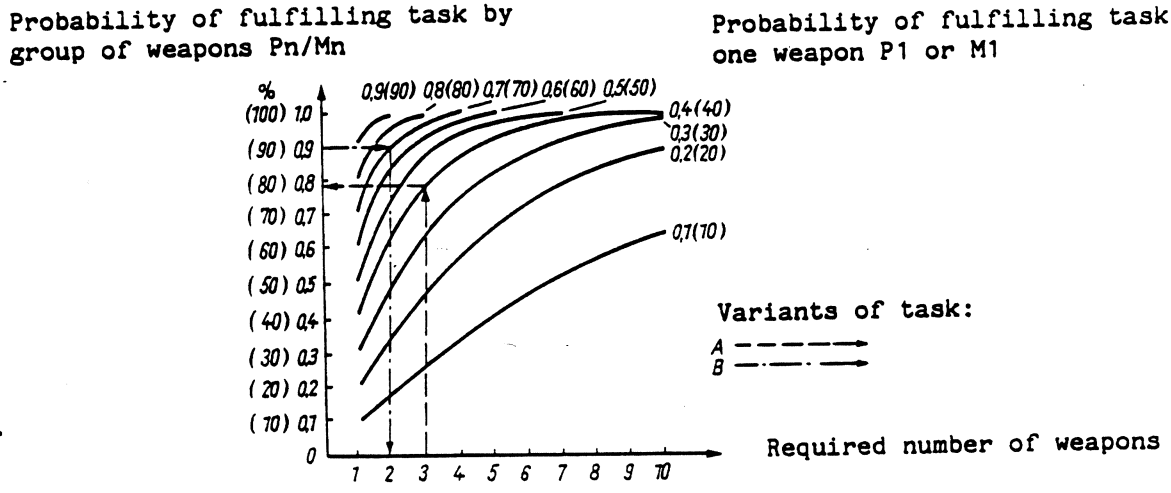

Figure 48. Nomogram for the Calculation of the Detail Necessary in the Evaluation of the Effectiveness of Several Weapons of the Same Type.

From the mark - "3" (variant a) on the scale "required number of weapons draw vertically up to the intersection with the curve". "Probability of fulfilling the tasks by one weapon" - "0.4". From the point of intersection draw a horizontal line and read off on the scale "Probability of fulfilling the task by a group of weapons".

Solution: The probability of destruction of an object by these weapons is 0.78 (78%).

By a similar calculation it is possible to determine the reliability of communications in a link which is made up from two channels (n = 2), if the reliability of each channel equals 0.6. According to the nomogram the probability of good communications on a given link would be 0.84 (84%).

Evaluate the effectiveness of using 4 similar means to locate of an enemy object in a given area, if the probability of detection by one means equals 0.5 (50%). According to the nomogram the probability of detection of the object would be near to absolute - 0.94 (94%).

2. Determine how many weapons are necessary to inflict damage of not less than 90% on an enemy object, if the average damage, inflicted by one weapon equals 70%.

From the mark "0.9 (90%)" on the scale "Probability of carrying out the tasks by a group of weapons" draw a horizontal line to the intersection with the curve "Probability of carrying out the task by one weapon" - 0.7 (70%).

From the point of intersection draw a vertical line to the scale "Required number of weapons" - the result is 2. That is, for the attainment of the required damage, two weapons are needed.

In a similar manner it is possible to determine the necessary number of communications channels to guarantee 90% reliability of communication, if the reliability of each channel is 0.6 (60%).

According to the nomogram for guaranteeing communications with the required reliability no less than three channels are necessary.

From the above examples, it is evident that this method can be used for the calculation of a wide variety of direct and indirect tasks.

The formula of the calculation of the effectiveness of forces and weapons (means) taking account of likely enemy counter-action is:

$$P_n = 1 - (1 - P_1 \times Q)^n$$

or

$$M_n = 1 - (1 - M_1 \times Q)^n$$

where:

P_n = Probability of accomplishment of tasks by a group of weapons (means).

P_1 = Probability of accomplishment of task by one weapon (means) of a given type.

Q = Probable index of enemy counter-action.

n = Number of forces and weapons of a given type to be used.

M_n = Mathematical expectancy (mean average) damage inflicted by a group of weapons (means) of a given type.

M_1 = Mathematical expectancy (mean average) of damage inflicted by one weapon (means) of a given type.

Example of Calculation.

Determine the probability of accomplishing a task by five weapons if the probability of destruction/damage of the target by one weapon is 60% (0.6), but the probability of enemy counter-action (damage by the enemy of our weapons) is 50% (0.5).

Solution:

$$P_n = 1 - (1 - 0.6 \times 0.5)^5 = 1 - (1 - 0.3)^5 = 1 - (0.7)^5 = 1 - 0.17 = 0.83$$

Solution - 83% probability.

Proforma No 5. The Determination of the Required Amount of Manpower and Weapons for Bringing Sub-Units up to Scale in the Restoration of their Battle Worthiness.

This calculation is made so as to establish how many men and weapons are needed to restore the sub-unit to battle worthiness. It is not envisaged that the refurbishment restores the sub-unit to its original establishment, but just to the necessary ratio of superiority of forces and weapons between the two sides.

The basic data needed for the calculation is information on the original full strength of the troops of the two sides, the losses sustained and the superiority ratio of manpower and weapons required for carrying out the task. The results of the calculation represent numbers necessary to restore to battle worthiness.

The formula of the calculation is:

$$M_i = C_i - \frac{A_i}{B_i}; \qquad A_i = (n_c - n_c \times P_c) \times N_c;$$

$$B_i = (n_n - n_n \times P_n) \times N_n; \qquad m_i = B_i \times M_i;$$

where:

M_i = The index of the reduction of battle worthiness resulting from the required ratio of manpower and weapons for the execution of the task.

C_i = The required level of superiority ratio for a particular type of weapon.

A_i = The availability of a number of weapons of a particular type of own forces.

B_i = The availability of a number of weapons of a particular type of enemy forces.

Table 106. Proforma for the Calculation of the Required Amount of Personnel and Equipment for the Replenishment of Sub-Units and the Restoration of Their Battle Fitness.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Forces and Equipment				Remarks
			Tanks	Guns	Mortars	Btr	
1	Initial full strength of own troops	%	0.85	0.7			Example of calc by the proforma
2	Casualties of own troops	%	0.4	0.2			To determine the required number of tanks and guns for the replenishment of a sub-unit if the set level of superiority is 2.5 from a full strengh of own forces of 85% (0.85), losses of own troops in tanks 40% (0.4); enemy forces full stength 60% (0.6) his casualties in tanks 40% (0.4). According to the proforma we find the replenishment of the sub-unit and restoration of battle worthiness requires 2 tanks.
3	Organic number of equipments of own troops	single	25	32			
4	(1) x (2)	(0.01)	0.34	0.14			
5	(1) - (4)	(0.01)	0.51	0.56			
6	(3) x (5)	(1.0)	13	18			
7	Initial full strength of enemy troops		0.6	0.6			
8	Casualties of enemy troops	%	0.4	0.3			
9	Organic number of equipments of enemy troops		18	25			
10	(7) x (8)	(0.01)	0.24	0.18			
11	(7) - (10)	(0.01)	0.36	0.42			
12	(9) - (11)	(1.0)	6	10			
13	The established level of superiority of own troops (deduced from relationship of forces and equipments)		2.5	1.5			
14	(6):(12)	(0.01)	2.17	1.8			

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Forces and Equipment				Remarks
			Tanks	Guns	Mortars	Btr	
15	(13) - (14)*	(0.01)	0.33	-0.3			
16	Number of equipments necessary for the replenishment: (12) x (15)	(1.0)	2	-			

*

In (15) < 0 the replenishment of forces and equipments is not required, the sub-unit is battle worthy and is able successfully to fulfil the given task beforehand.

Appendix 3 to Annex E

NOMOGRAM 15. Duration of a Crossing with one Ferry.

The duration of a 'wave' * is dependent on the character of the water obstacle and the ferrying equipments and furthermore the time required for loading and unloading equipment and cargo from the ferry.

The basic data required for the calculation is the width of the water obstacle, speed of the current, speed of movement of the ferrying means (swimming) and; time necessary for the loading and unloading of equipment or cargo.

In method of calculation:

$$t = \frac{2D}{V}(1 + 0.3V_B) + t_1$$

where:

t = Duration of one 'wave' of ferrying means - mins.

D = Width of water obstacle - m.

V = Ferry speed - m/min.

V_B = Speed of current - m/sec.

t_1 = Time necessary for loading/unloading.

---

* A "wave" is the term used to describe a single passage across a water obstacle by one or by a group of several items of amphibious assault equipment (ferry, APC, etc.).

Example of calculation.

To determine the duration of a "wave" of ferries swimming speed 8kph (133m/min) if the width of the water obstacle is 360m, current speed 2.5m/min, duration of loading/unloading 12mins.

Solution:

$$t = \frac{2 \times 360}{133} (1 + 0.3 \times 2.5) + 12 = 22\text{mins}$$

Example of calculation using nomogram.

To determine the duration of a crossing, swimming speed 9.5kph (160 m/min) if the width of the river is 250m, speed of current 2m/sec, time for loading/unloading 6 mins.

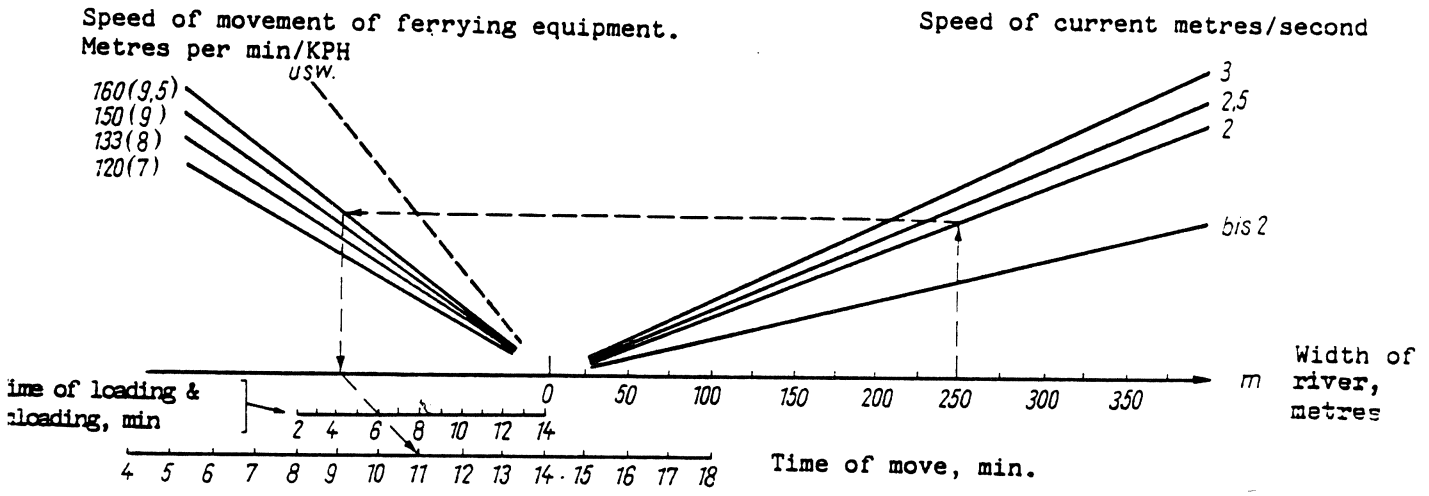

Figure 49. Nomogram for the Calculation of the Duration of a Crossing with One Ferry.

The nomogram gives 11mins as duration of a crossing.

Further calculations can be made to determine the overall time of a crossing. As in the example the overall time on the given sector (if for the operation 15 crossings are required) = 11mins x 15 = 165mins = 2hr and 45mins.

NOMOGRAM 16. Duration of Water Crossing of Tanks in a Deep Ford or Submerged (Schnorkelling).

The basic data needed for the calculation is: the number of tanks to cross; the established time for the crossing, and; the width of the river and time of the day.

Formula of the calculation:

Duration of tank water crossings:

$$t = \frac{(D + N \times d) \times 0.06}{V \times n}$$

Number of tanks in a given time:

$$N = \frac{t \times V \times n - 0.06D}{0.06d}$$

where:

t = Duration of tanks crossing - mins.

D = Width of river or length of underwater track.

N = Number of tanks.

d = Distance between vehicles.

0.06 = Coefficient converting kph into m/min.

V = Speed of tanks under water - m/min.

n = Number of underwater crossing tracks.

Example of calculation.

1. Determine the duration of a water crossing of 18 tanks on one path across a water obstacle of 280m in width, interval between vehicles 60m, swimming speed 8kph.

Solution:

$$t = \frac{(280 + 18 \times 60) \times 0.06}{8} = 10\text{mins}$$

2. To determine how many tanks can cross a river 360m wide in 25mins on one path, if the speed of the tanks 6kph and distance between vehicles 120m.

Solution:

$$N = \frac{25 \times 6 - 0.06 \times 360}{0.06 \times 120} = 18 \text{ tanks}$$

Examples of calculation using nomogram.

1. To determine the duration of a crossing of 15 tanks, underwater on one path at night across a water obstacle 300m wide.

Solution: (variant a) - 18mins.

2. To determine how many tanks can cross under water a river 250m wide, by day, on one path, in 15 mins.

Solution: (variant b) - 25 tanks.

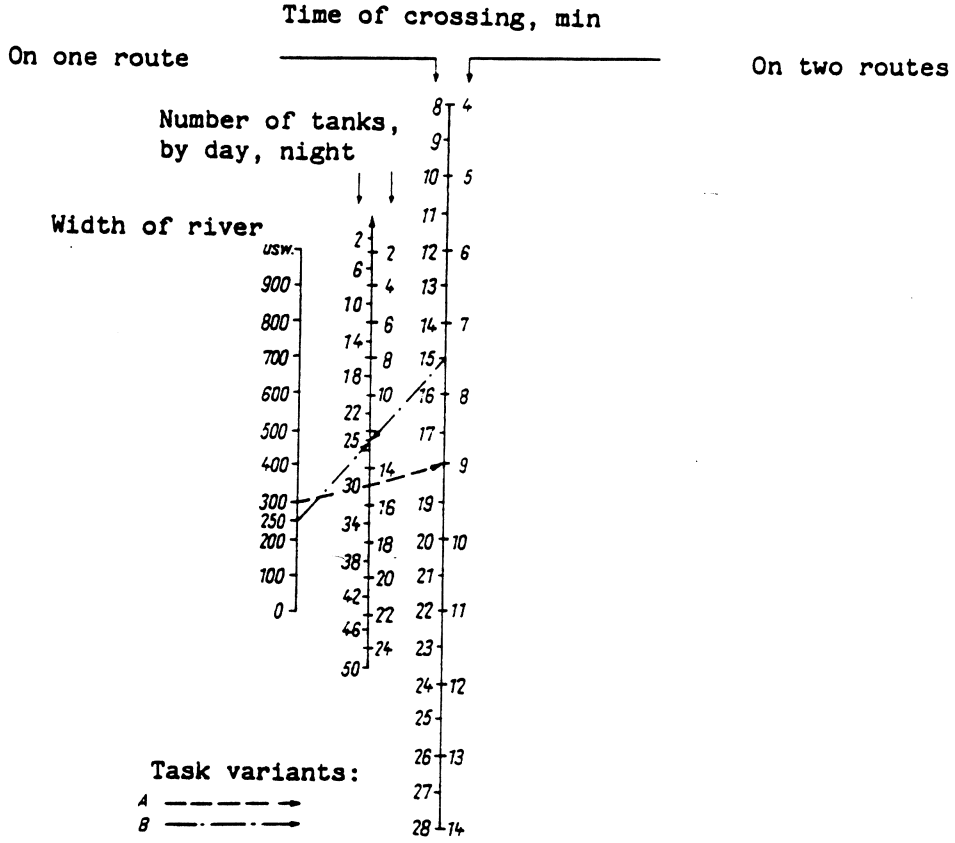

Figure 50. Nomogram for the Calculation of Tanks Crossing Underwater.

NOMOGRAM 17. Duration of a Water Crossing.

This is the method for establishing the duration of a forced crossing by amphibious assault equipments. The basic data needed for the calculation is: the required number of crossing points; the number of amphibious equipments, and; the duration of one wave.

Formula of calculation:

$$t = \frac{M \times t_p}{N}$$

where:

t = Duration of the crossing - mins.

M = Required number of waves.

t_p = Duration of one wave.

N = Allotted number of amphibious assault equipments.

Example of calculation.

Determine the duration of a crossing of 168 vehicles in 84 vehicles "waves", the duration of each "wave" is 15mins, for each crossing 24 amphibious equipments are allocated.

$$t = \frac{84 \times 15}{24} = 52 \text{ mins}$$

Example of calculation by nomogram.

1. To determine the duration of crossing of equipment if 88 vehicle waves are required, duration of one wave 12 mins, number of ferring equipments 15.

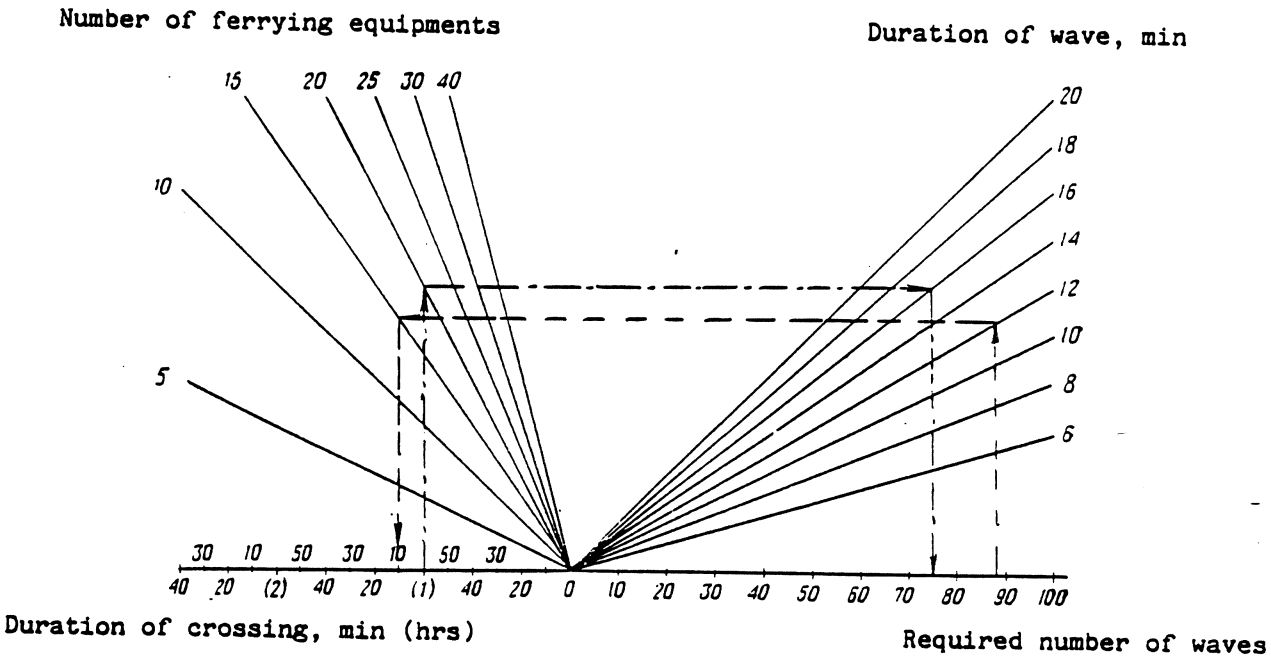

Figure 51. Nomogram for the Calculation of the Duration of a Water Crossing.

Solution: (variant a) - 1hr 10mins.

2. On the nomogram it is possible to solve an inverse task. To determine the total duration of the crossing if the duration of each wave is 16mins, number of ferrying equipment 20 and each ferrying equipment carries one vehicle.

Solution: (variant b) - 75 vehicles per hr.

NOMOGRAM 18. Calculation of the Number of Mines for the Construction of a Mine Obstacle.

The basic data needed for the calculation is the extent of the line/feature, which it is necessary to cover with an established density of mining, with an available number of mines and the density of the obstacles necessary on a given feature.

Formula of calculation:

1. Required number of mines:

$$N = D \times P \times n$$

2. Extent covered by the obstacles on the feature:

$$D = \frac{N}{P \times n}$$

3. Density of obstacle:

$$P = \frac{N}{D \times n}$$

where:

N = Required number of mines for the construction of the obstacles.

D = Front of feature, which is to be covered by mines.

P = Density of obstacle (extent of minefield - per km).

n = Density of mining (number of mines - per km).

Example of calculations.

1. Determine the required number of mines for obstacles on a feature 9.6km with a density of obstacles 0.85 (850m of minefield per km of frontage of the protected feature) with a density of mining 750 mines on 1km of

minefield.

Solution:

$$N = 9.6 \times 0.85 \times 750 = 6120 \text{ mines}$$

2. Determine the extent of a feature which it is possible to protect by obstacles having availabile 2850 mines. The required density of obstacles 0.75, i.e. a density of mining of 750 mines per km of minefield.

Solution:

$$D = \frac{2850}{750 \times 0.75} = 5\text{km}$$

3. Calculate the density of obstacles on a feature of 7.5km long, if the expenditure of 4780 mines in a density of mining 800 mines per 1km of minefield.

Solution:

$$P = \frac{4760}{7.5 \times 800} = 0.8$$

Examples of calculation using nomogram.

1. To determine the required number of mines for the protection by mined obstacles of a feature 6.5km long, if the obstacle density is 0.6 and the density of mining 700 mines to 1km of front.

Solution: (variant a - 2730 mines).

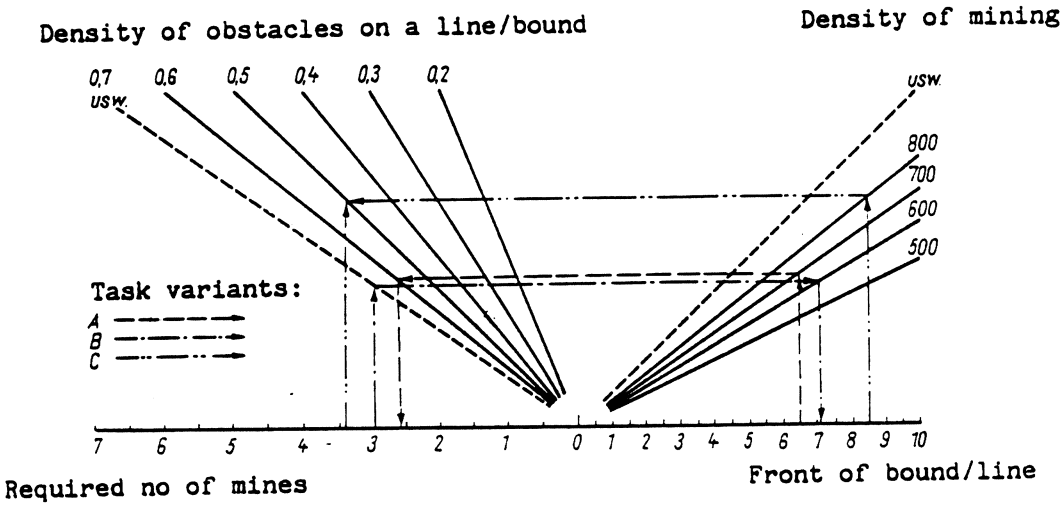

Figure 52. Nomogram for the Calculation of the Required Number of Mines in Constructing a Minefield Obstacle.

2. Determine the length of a feature, which is to be protected by minefield obstacles with an availability of 3,000 mines, if the density of mining is 600 mines on 1km of minefield, obstacle density 0.7.

Solution: (variant b) - a frontage of 7.1km.

3. Calculate the density of obstacles on a feature 8.5km long, if 3400 mines are to be expended in a density of mining 800 mines to 1km of minefield.

Solution: (variant a) - 0.5km of obstacles on 1km of the protected feature.

Table 107. Proforma for the Calculation of Manpower and Equipment, Necessary for the Construction of an Engineer Fortification on the Ground.

Ser No.	Designated Constructions	Number of Constr-uction	Norms on Construction		Man Days (3)* x (4)	Machine Hours (3) x (5)	Remarks
			Man Days	Machine Hours			
1	2	3	4	5	6	7	8
1	Single track for riflemen	128	0.15	-	19.2	-	Example of calc by proforma
2	Sector trenches	6	10.5	-	63	-	To determine the required no
3	MG trenches	15	0.25	-	3.75	-	of manpower and equipment for
4	10m trenches	20	1.2	-	24	-	the erection in two days of
5	Gunpit - 100mm gun	-	4	0.5	-		the following fortifications
6	Gunpit - 122mm	3	4.5	0.7	13.5	2.1	- see column 3.
7	Gunpit - 120mm Mor	3	3.5	-	10.5	-	The ordered for -tifications
8	Pit for BTR	18	0.2	1.0	3.6	18	require 222.45 (~223) men days
9	Pit for tank	-	1.1	1.4	-	-	and 27.5 machine hours
10	Op	5	0.5	-	2.5	-	of earth moving equipment.
11	Open slit trench	3	1.0	-	3	-	The number of personnel which
12	Covered trench-section	4	3.5	-	14	-	are required in the course of 2
13	Shelter	4	12.3	-	49.2	-	days consist of 223:2 ~ 112

See also Annex H for detail of norms.

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* Figures in brackets

Ser No.	Designated Constructions	Number of Constr-uction	Norms on Construction		Man Days (3)* x (4)	Machine Hours (3) x (5)	Remarks
			Man Days	Machine Hours			
1	2	3	4	5	6	7	8
14	Cover for GAZ-69, GAZ-66	6	1.2	0.5	7.2	3	men; Besides one bulldozer is required since $\frac{30.5}{2.20} = 1$
15	Cover for ZIL-157	4	1	0.6	4	2.4	
16	Cover for BTR	5	1	0.4	5	2	
17	In all in lines (6) and (7)	-	-	-	222.45	27.5	

* Figures in brackets

Table 108. Proforma for the Calculation of the Duration of a River Crossing of Sub-Units on Amphibious Assault Equipment.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant				Remarks
1	Number of tanks to be found on GSP	single (1.0)	16				Example of calculation by the proforma. To determine the duration of a crossing of sub-units, consisting if 34 tanks and 67 vehicles, with the allotted number of amphibious assault equipment: (GSP-3, PTS-4, ferries 3). Capacity of ferries 1 x tank or 4 x wheeled vehicles. By calculation overall ferrying time - 2hrs but duration of tank ferrying serial (16) - 1.5hrs
2	Number of tanks to be found on ferries	single (1.0)	18				
3	Number of wheeled vehicles to be found	single (1.0)	67				
4	Number of GSP	single (1.0)	3				
5	Number of PTS	single (1.0)	4				
6	Number of ferries	single (1.0)	3				
7	Capacity of ferries (according to wheeled vehicles)	single (1.0)	4				
8	Duration of wave GSP	min (1.0)	13				
9	Duration of Wave PTS	min (1.0)	12				
10	Duration of wave - ferries	min (1.0)	15				
11	(1) x (8)	(10)	210				
12	(11):(4)	(10)	70				
13	(2) x (10)	(10)	270				
14	(13):(6)	(10)	90				
15	To select the greater: (12) or (14)	(10)	90				

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant				Remarks
16	Duration of ferrying the tanks: (15):60	hrs (0.1)	1.5				
17	(5) x 60	(1.0)	240				
18	(17):(9)	(1.0)	20				
19	(18) x (16)	(1.0)	30				
20	(3) - (19)	(1.0)	37				
21	(6) x ( )	(1.0)	12				
22	(21) x 60	(1.0)	720				
23	(23):(10)	(1.0)	48				
24	(23) + (18)	(1.0)	68				
25	(20):(24)	(0.1)	0.5				
26	Overall duration of ferrying (16) + (25)	has (0.1)	2.0				

Note: In the (20) < the calculation ends, since the overall time of the crossing is equal to the time of ferrying the tanks.

Appendix 4 to Annex E

NOMOGRAM 19. Engagement of Personnel and Weapons by Artillery Fire *.

The data for the calculation consists of:

a. Number of guns and their calibre (also mortars).

b. Characteristics of the target (area of target).

c. Level of protection of personnel and weapons in the target area.

d. Fire mission - (destruction, neutralisation).

e. Planned duration of fire.

The formula of calculation.

$$S_i = \frac{N_i \times n_i}{m_i}$$

where:

S_i = Area for the engagement of personnel and weapons - in hectares.

N_i = Number of guns/mortars and calibre.

n_i = Number of rounds per gun/mortar per min dependent on max, permitted rates of fire.

m_i = Density of rounds per hectare.

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* Taktícheskiye Raschety, p50/51.

Example of calculation.

Determine the area of neutralisation of personnel and weapons by a fire mission of 18 x 122mm How for a duration of 5 minutes, if each gun according to the maximum permitted rates of fire in that time fires 25 rounds, the required rounds on 1 hectare = 8 rounds.

$$S = \frac{18 \times 25}{80} = 5.6 \text{ hectares}$$

Examples of calculation according to the Graph.*

1. To determine the effective fire probability of 12 x 122mm Hows in the neutralisation of personnel in the open for 15 minutes.

On the graph with the "dashed red line" from the point "15" minutes on the "duration of fire" scale go upwards until the dashed red line nears the maximum permitted rates of fire curve for 122mm How. From this point follow the dashed red line horizontally across to where it cuts the "number of guns - 12" line. Then follow the dashed red line downwards until it cuts 122mm line - troops in open. From here horizontally across to where it cuts the area in number of hectares line at 33**.

2. Determine the duration of fire by 12 122mm How on personnel in the open, area 20 hectares. Solving the task - from point 20 on area of "engagement" scale go horizontally across to where it cuts 122mm How line - "troops and weapons in the open" - then go vertically upwards number of guns - 12 - then go horizontally to where the line cuts the line ("maximum permitted rates of fire 122mm How") - from this intersection down vertically to the duration of fire scale in minutes - the result is 7 mins.

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* Takticheskiye Raschety, p51.

** This line should cut exactly on 33. But error can caused by improper curve between 10 and 20 mins on maximum permitted rates of fire graph on incorrect reproduction of 'Quantity' of guns required - 12 guns.

3. To determine how many 100mm guns and ammunition are required for the neutralisation of a hastily occupied strongpoint - area 7.2 hectares for 10 mins.

From line at point "10 min duration" of this scale go upwards to where it intersects "maximum permitted rates of fire" curve for 100mm gun. From there left horizontally. From the point 7.2 hectares in area of "engagement" scale go horizontally left to where it cuts 100mm gun on "unobserved protected personnel and weapons" scale and further vertically to where it cuts the "number of guns required" - 36 scale. The point where this line crosses the "amount of ammunition required scale" is 1800 rounds.

NOMOGRAM 20. Duration of Fire Without a Change of Gun Position.

Formula of Calculation:

$$t = 60 \times \left(\frac{D - d}{V_B} - \frac{D - d}{V_{cm}}\right) - t_c$$

or

$$t = 60(D - d)\left\{\frac{1}{V_B} - \frac{1}{V_{cm}}\right\} - t_c$$

where:

t = Duration of fire without a change of gun positions or time on one position - mins.

D = Actual distance of effective fire - km.

d = Established distance of gun position from the forward line of own troops - km.

V_B = Speed of advance of own troops - kph.

V_{cm} = Speed of guns/weapons in moving positions - kph.

60 = Coefficient for converting hrs to mins.

t_c = Time allowed for vacating position/occupying position.

Example of calculation.

To determine the duration of fire from mortars without moving positions if:

distance of position from front own troops - 3km - d

actual distance of effective fire - 7.5km - D

speed of advance own troops - 5km - V_B

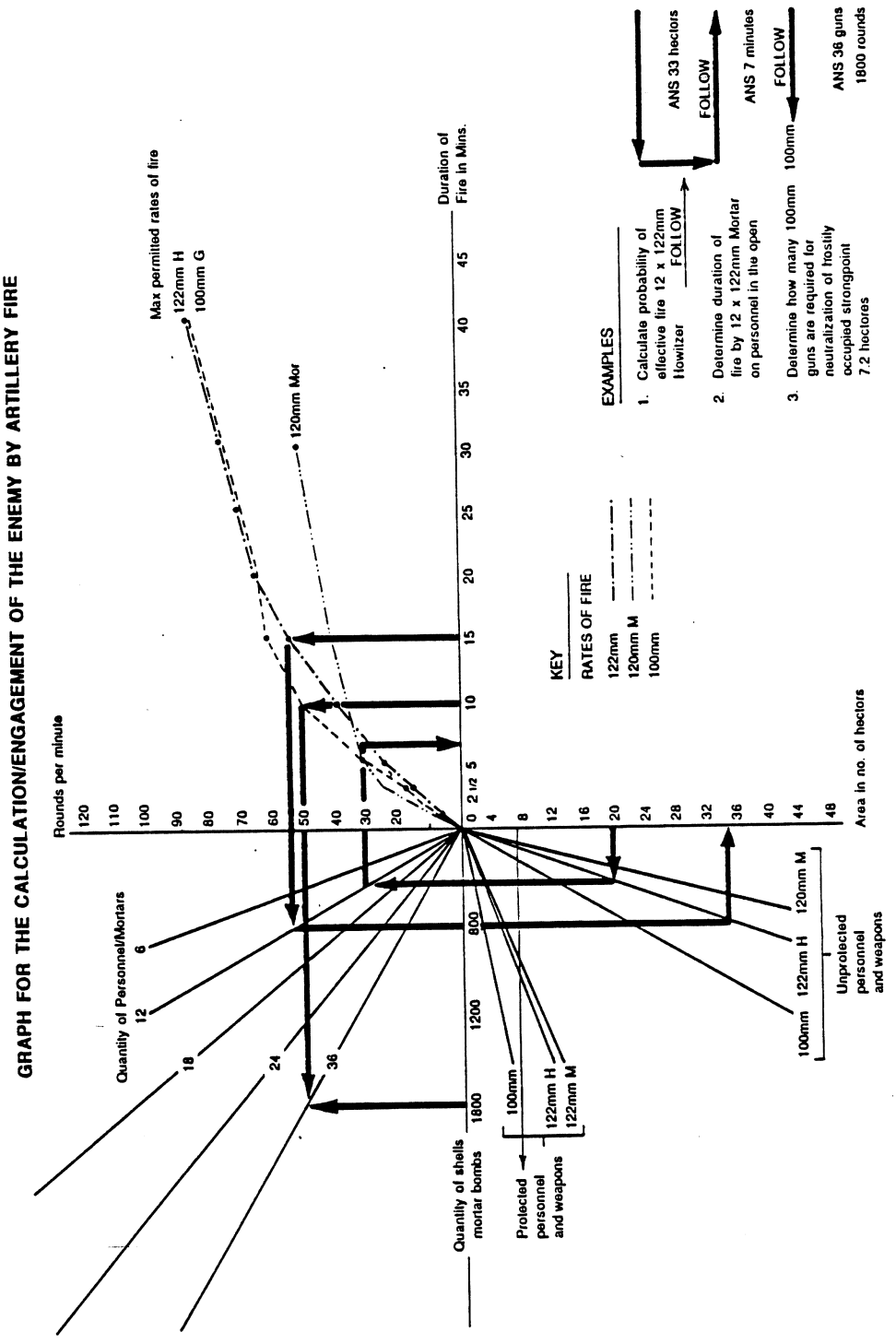

GRAPH FOR THE CALCULATION/ENGAGEMENT OF THE ENEMY BY ARTILLERY FIRE
Max permitted rates of fire
122mm H
100mm G
120mm Mor
Duration of Fire in Mins.
Rounds per minute
Quantity of Personnel/Mortars
Quantity of shells mortar bombs
Protected personnel and weapons
Unprotected personnel and weapons
Area in no. of hectors
KEY
RATES OF FIRE
122mm
120mm M
100mm
EXAMPLES
1. Calculate probability of effective fire 12 x 122mm Howitzer
FOLLOW
ANS 33 hectors
2. Determine duration of fire by 12 x 122mm Mortar on personnel in the open
ANS 7 minutes
3. Determine how many 100mm guns are required for neutralization of hostily occupied strongpoint 7.2 hectares
100mm
FOLLOW
ANS 36 guns
1800 rounds

Figure 53. Graph for the Calculation/Engagement of the Enemy by Artillery Fire.

speed of sub-units in moving position - 25kph - V_{cm}

time for vacating/occupying positions - 15mins - t_c

$$t = \left(\frac{(7.5 - 3)}{5} - \frac{(7.5 - 3)}{25}\right) \times 60 - 15$$

$$= \left(\frac{4.5}{5} - \frac{4.5}{25}\right) \times 60 - 15$$

$$= (0.9 - 0.18) \times 60 - 15$$

$$= 0.72 \times 60 - 15$$

$$= 43 - 15$$

$$= \underline{28\text{mins}}$$

Range of mortars.

Example of calculation according to graph using Figure 54.

1. Determine the actual firing time of guns on one fire position if:

distance of position from front own troops - 6km - d

actual distance of effective fire - 14km - D

speed of advance own troops - 6kph - V_B

speed of sub-unit in moving positions - 15kph - V_{cm}

2. It is necessary to determine the difference between D and d. This is 8km. On both "firing range less distance own troops" scales make a mark at distance 8. From 'B' on the lower scale draw vertically to "speed of advancing sub-units - 6". From 8 on the upper scale we draw another perpendicular to "15 - on fire weapons speed line".

From both points of intersection draw horizontal lines to scales I and II. From scale I draw a line writing scale II (where horizontal from "15" on fire weapons speed cuts) through to "duration of time of guns/weapons on position". From this we read off - 48 mins. However for 'out of a crisis' and occupation of said position allow 20 mins, therefore length of time on gun position cannot be more than 28 mins.

A quick check with the formula gives us 28 mins - see working below:

$D = 14km$

$d = 6km$

$V_B = 6kph$

$V_{cm} = 15kph$

$t_c = 20min$

$$t = \left(\frac{(D-d)}{V_B} - \frac{(D-d)}{V_{cm}}\right) \times 60 - 20$$

$$= \frac{14-6}{6} - \frac{14-6}{15} \times 60 - 20$$

$$= \frac{8}{6} - \frac{8}{15} \times 60 - 20$$

$$= 1.33 - 0.53 \times 60 - 20$$

$$= 48 - 20 = 28mins$$

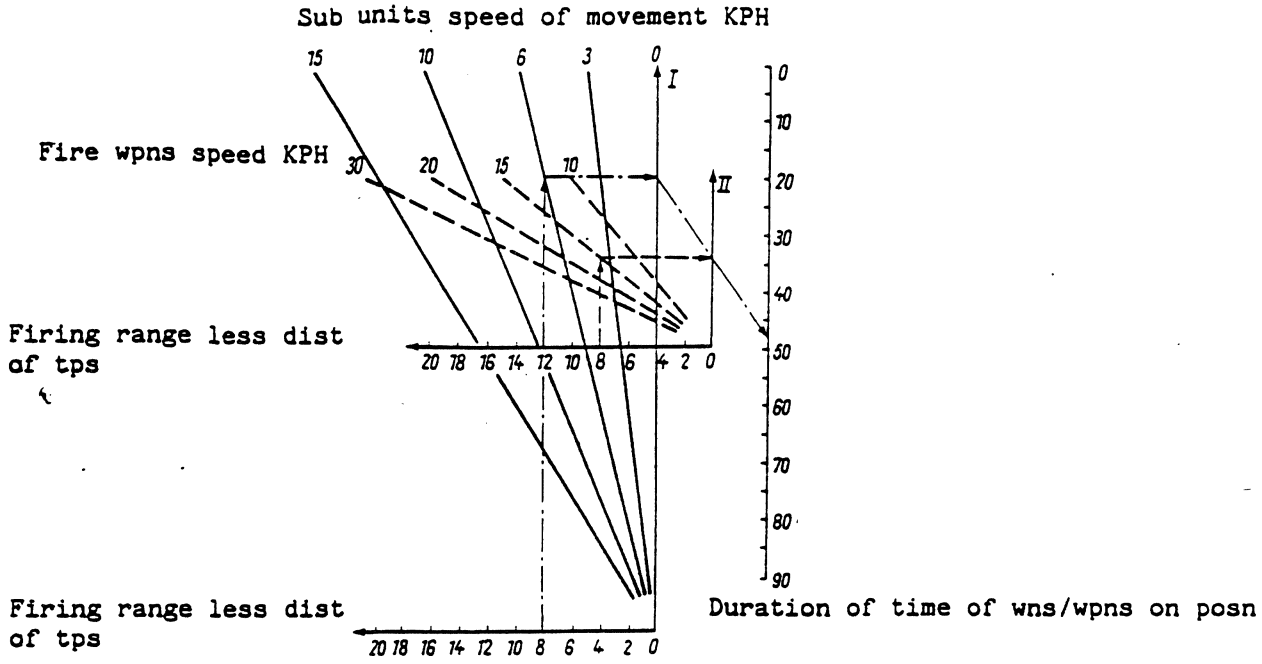


Figure 54. Duration of Fire Without Changing own Position.

NOMOGRAM 21. Time Spent in Changing Gun Position.

Formula of calculation:

$$t = \frac{60 \times D}{V} + t_1 + t_2$$

where:

t = Time spent in changing positions - mins.

60 = Coefficient for converting hrs to mins.

D = Distance away of new position - km.

V = Speed of movement during change - kph.

t_1 = Time spent vacating position.

t_2 = Time spent occupying new position.

Example of formula.

To determine the time spent in changing positions if:

D = 15km

V = 35kph

t_1 = 12mins

t_2 = 15mins

$$t = \frac{60 \times 15}{35} + 12 + 15 = 53\text{mins } (52.71\text{mins})$$

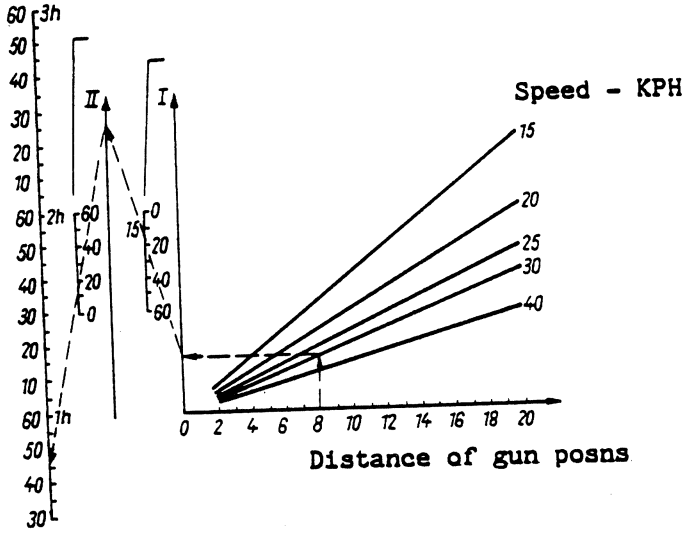
Example by graph using Figure 21.

D = 8km

V = 30kph

t_1 = 15mins

t_2 = 15mins



Time spent in changing gun positions

Figure 55. Time Spent in Changing Gun Position.

Proforma No 7. Calculation of the Fire Capabilities of Artillery.

The method for the determination of the overall area of engagement of enemy personnel situated in the open by the available number of guns (mortars) comes from a planned duration of fire.

The data for the calculation is the information about the number and type of guns (mortars) allotted for the engagement, depending on the rate of fire of a given type of gun or mortar.

The formula of calculation:

$$S = \sum_{i=1}^{n} \frac{N_i \times n_i}{m_i}$$

where:

S = The overall area of engagement of the enemy with a determined number of guns and mortars in a set time - hectares.

N_i = The number of allotted guns (mortars) of the i th type.

n_i = The number of shells (bombs) fired by one gun (mortar) of the i th calibre in a set time of firing - shells.

m_i = The number of shells (bombs) required for the necessary engagement of the enemy on one hectare of the target.

In the calculation the calculating proforma (Table 109) is used.

Table 109. Proforma for the Calculation of Artillery Capability.

Ser No.	Starting Data Determined Scales and Operations	Degree of Accuracy	Calculation Variant			Remarks
			Example	1	2	
1	Number of 122mm guns	single (1.0)	18			
2	Number of rounds expended during the fire mission (intense)	shell (1.0)	40			10mins. Rounds per gun. 4 rounds per min
3	Number of 100mm guns	single (1.0)	12			
4	Number of rounds expended during the fire mission (intense)	shell (1.0)	50			
5	Number of 120mm mortars	single (1.0)	12			
6	Number of bombs expended during the fire mission (intense)	bomb (1.0)	35			
7	(1) x (2)	(1.0)	720			
8	(7):20	(0.1)	36			
9	(3) x (4)	(1.0)	600			
10	(9) x 30	(0.1)	20			
11	(5) x (6)	(1.0)	420			
12	(11):60	(0.1)	42			
13	Overall area of engagement of the enemy (8) + (10) + (12)	hectares (1.0)	98			